

DOCUMENT RESUME

ED 033 856

SF 007 607

AUTHOR Hotchkiss, Neil
TITLE Underwater and Floating-Leaved Plants of the United States and Canada.
INSTITUTION Department of Interior, Washington, D.C.
Fish and Wildlife Service.
Pub Date May 67
Note 132p.
Available from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402
\$0.65
EDRS Price EDRS Price MF-\$0.75 HC Not Available from EDRS.
Descriptors Biology, *Botany, Ecology, Cutdcor Education, *Plant Identification, Reference Books

Abstract

This is the third in a series of guides to the field identification of North American marsh and water plants. Described are plants which have foliage habitually under water or floating, or which have underwater or floating forms, and which have characteristics by which they can be distinguished with the naked eye. Where genera or species cannot be distinguished with the naked eye, only group descriptions are given. The plants are divided into twelve main groups on obvious structural characteristics; once the reader has decided to which of these groups a plant belongs, he should look at the illustrations of plants in the group and read their descriptions until he has a match. Each illustration and description is headed with a common name and scientific name; in general no attempt is made to indicate the classification of the plant beyond the genus. Plants are indexed by both species name and common name. (EB)

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UNDERWATER AND FLOATING-LEAVED PLANTS OF THE UNITED STATES AND CANADA



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North American Marsh and Water Plants

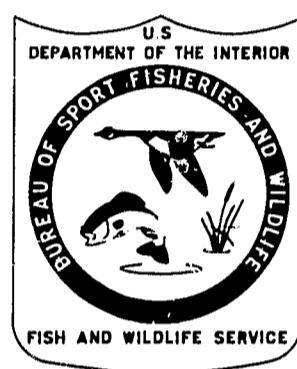
The preceding two pamphlets in this group of guides to identification of aquatic plants were published as units of a projected series on "Aquatic Plants of Eastern North America." Those two were Pondweeds and Pondweedlike Plants of Eastern North America issued in May 1964 as Fish and Wildlife Circular 187, and Bulrushes and Bulrushlike Plants of Eastern North America issued in May 1965 as FWS Circular 221.

The acceptance accorded the first two pamphlets and comments received about them demonstrate the need for extending the coverage to all of the continental United States and Canada and increasing the number of plants discussed under one cover. For these reasons plants discussed in Circular 187 are included also in this publication.

UNDERWATER AND FLOATING-LEAVED PLANTS OF THE UNITED STATES AND CANADA

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Published by
Bureau of Sport Fisheries and Wildlife
Resource Publication 44
Washington, D. C. • May 1967

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 65 cents

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UNDERWATER AND FLOATING-LEAVED PLANTS OF THE UNITED STATES AND CANADA

This is the third of a series of circulars on field identification of North American marsh and water plants. It describes all of the wild flowering plants, ferns, liverworts, and Characeae in which the foliage is habitually under water or floating, and all those which have underwater or floating-leaved forms, and which, at the same time, have characteristics by which a person can tell them apart with the naked eye. If the different kinds cannot be told apart without a hand lens or microscope or when they are without flowers or seeds, only group descriptions are given.

To use this guide, a person should read pages 1 to 5 and the introductions to each of the twelve groups, and should scan the pictures. Then, to identify a particular plant, he should find the group and the picture which match it, and read the description which goes with that picture. If the picture and description fit the plant, a name has been found for it.

These plants range from pinhead-size to twenty feet long. Most of the pictures are life-size or half life-size, as indicated; but many show no more than a sprig of a much-branched plant. This tells little of how an entire plant looks, or how dense patches look. But a person usually sees water plants from above them, then breaks off a piece for a closer look; or he salvages an already broken piece. So what is pictured here should be enough for identification.

Each description is headed with a common name and a scientific name. Under some of these headings, in parentheses, are one or more other scientific names which are used for the same plant in three commonly used manuals: Merritt Lyndon Fernald's "Gray's Manual of Botany, Eighth Edition" (1950); Herbert L. Mason's "A Flora of the Marshes of California" (1957); and John Kunkel Small's "Manual of the Southeastern Flora" (1933).

Seeds and rootstocks of many Pondweeds and of Widgeongrass, Wildcelery, Eelgrass, and Shoalgrass are important duck foods from fall to spring; and ducks, geese, muskrats, turtles, fish, insects, and other animals make some use of every plant described. When water plants get in the way of boating, swimming, or fishing they are quickly labeled "weeds". Then it's worth remembering that they protect bottoms from currents which stir up mud and sand, protect shores from waves, give fish places where temperatures are moderate and there is plenty of food and oxygen, and are interesting and beautiful.

Underwater plants are abundant in shallow, clear, still or slow-flowing, fresh water from southern British Columbia to southern Quebec, and south to the Great Basin, the Nebraska Sandhills, and the Great Lakes States. They are less common, but still in great variety, northwest to Alaska, northeast to Newfoundland, and east through New England. Farther north, short summers eliminate most of them. South of the main area they are only locally common because the water in most places is muddier, warmer, or more fluctuating than they can bear.

A few kinds (Eelgrass, Surfgrass, Shoalgrass, Manateegrass, Turtlegrass, and Halophila) grow only in salt water in coastal bays, rivers, and creeks. Ribbonlike or threadlike green leaves distinguish them from the algae which grow nearby. Widgeongrass, Sago Pondweed, Horned-pondweed, Redhead-grass, and Eurasian Watermilfoil grow both inland and in fresh to brackish coastal water; and a larger number of mainly inland plants reach the coast in fresh to slightly brackish water.

Floating-leaved plants are occasional in fresh to slightly brackish water nearly everywhere that underwater plants are abundant or common. They are also common south along the Atlantic and Gulf Coastal Plain.

About half of the kinds of plants described here have flexible underwater stems which grow vertically, slantwise, or horizontally, and are thinly to densely covered with leaves or branchlets (Groups 3 to 8). The stems and foliage of most of these plants are so limp that when taken out of water for a closer look they slump into a characterless mass. To separate leaves and leaflets, a person can lay the plant flat and splash water over it; put it in a shallow dish of water; or shake the leaves apart after they have half-dried.

About one-fourth of the plants described grow under water, but have short stems or limp to stiff leaves coming up from the bottom (Groups 1 and 2).

Another fourth have leaves which float at the ends of stalks which come from the bottom or from flexible underwater stems, or leaves which float free of any attachment (Groups 9 to 12).

Many of the plants do not grow exclusively under water or on its surface. Some are under water as seedlings, and later produce floating leaves or out-of-water leaves. In others, the spring growth from overwintering underground parts is under water; the mature growth reaches the surface of the water or above it. Some kinds have underwater, floating-leaved, and out-of-water forms which look so different that it is hard to believe they are related.

Floods temporarily submerged many kinds of plants that habitually live out of water and that cannot survive long under it. These are omitted.

The plants are discussed in twelve groups, each group beginning with northern inland plants and continuing through southern inland to strictly coastal ones.

Group 1. Plants with limp, threadlike to ribbonlike leaves coming up from the bottom or from short vertical stems; sometimes partly floating (pages 5-13)

Slender Spikerush (see Group 2)	Wildcelery
Burreeds	Flowering-rush
Quillworts (see Group 2)	Eelgrass
Arrowheads (see Groups 2 & 10)	Surfgrass
Northern Mannagrass & Wildrice	Shoalgrass
Water Bulrush	Manateegrass
Narrowleaf Waterplantain	Turtlegrass

Group 2. Plants with rather stiff, short leaves or nearly leafless stems in clumps or patches on the bottom; some kinds sometimes out of water (pages 14-30)

Slender Spikerush	Bog Rush
Creeping Buttercup	Horned Bladderwort
Quillworts	Zigzag Bladderwort
Subularia	Lavender Bladderwort
Arrowheads	Flowering-quillwort
Limosella	Pillwort
Water Lobelia	Western Lilaeopsis
Dwarf Spikerush	Eastern Lilaeopsis
Littorella	Gulf Halophila
Leafless Watermilfoil	Caribbean Halophila
Pipeworts	

Group 3. Plants with featherlike, usually limp leaves on flexible underwater stems; stem tips often sticking out of water (pages 31-42)

Northern Watermilfoil	Eurasian Watermilfoil
Little Watermilfoil	Parrotfeather
Whorled Watermilfoil	Eastern Watermilfoil
Variable Watermilfoil	Featherfoil
Farwell Watermilfoil	Andean Watermilfoil
Marsh Mermaidweed	Southern Watermilfoil
Low Watermilfoil	

Group 4. Plants with fine-forked, limp leaves mixed with small, roundish bladders on flexible underwater stems; flowers sticking out of water (pages 43-50)

Northern Bladderwort	Eastern Bladderwort
Flatleaf Bladderwort	Little Floating Bladderwort
Common Bladderwort	Big Floating Bladderwort
Hidden-flower Bladderwort	Dwarf Bladderwort
Purple Bladderwort	Giant Bladderwort

Group 5. Plants with clustered branches or fine-forked, bladderless, usually limp leaves on flexible underwater stems; stem tips sometimes sticking out of water (pages 51-59)

Muskgrasses, Nitellas & Tolypellas	Lake Cress
White Water Buttercup	Riverweed
Yellow Water Buttercup	Fanwort
Coontail	Alga Bulrush
Water-marigold	Limnophila

Group 6. Plants with needlelike to oval, paired or bunched leaves on mainly flexible underwater stems; some kinds sometimes out of water (pages 60-70)

Marestail	Marsh-purslane
Water-starworts	Spiny Naiad
Tillaea	South American Elodea
Horned-pondweed	Water-purslane
Waterworts	Creeping Rush
Naiads (except Spiny Naiad)	Micranthemum
Common Elodea	Mayaca
Goldenpert	

Group 7. Plants with threadlike to ribbonlike leaves scattered singly on flexible underwater stems, but often paired or bunched toward the stem tips; a few kinds also with oblong to oval floating leaves (pages 71-80)

Threadleaf Pondweed	Leafy Pondweed
Sago Pondweed	Bluntleaf Pondweed
Widgeongrass	Snailseed Pondweed
Bigsheath Pondweed	Alga Pondweed
Slender Pondweed	Fern Pondweed
Fries Pondweed	Water-stargrass
Flatstem Pondweed	Vasey Pondweed
Ribbonleaf Pondweed	Western Pondweed

Group 8. Plants with lance-shaped to oval leaves scattered singly on flexible underwater stems, but often paired or bunched toward the stem tips; some kinds also with oblong to oval floating leaves (pages 81-86)

Red Pondweed	Redhead-grass
Variable Pondweed	Bigleaf Pondweed
Whitestem Pondweed	Curly Pondweed

Group 9. Plants with lance-shaped to round floating leaves which are tapered to slightly notched at the base; some kinds also with thread-like to oval underwater leaves; and some kinds also growing partly out of water (pages 87-100)

Floating Pondweed	American Lotus
Oakes Pondweed	Upright Burhead
Water Smartweed	Longleaf Mudplantain
Marsh Smartweed	Goldenclub
Bog Pondweed	Damasonium
Watershield	Water Arrowhead (see Group 2)
Longleaf Pondweed	Watergrass
Broadleaf Waterplantain	Amphianthus
Roundleaf Bacopa	Salvinia
Heartleaf Pondweed	Ottelia

Group 10. Plants with lance-shaped to round floating leaves which are deeply notched at the base; a few kinds also growing partly out of water (pages 101-110)

Spatterdock	Roundleaf Mudplantain
Floating Caltha	Yellow Floatingheart
Northern Waterlily	American Frogbit
Northern Arrowhead	Big Floatingheart
White Waterlily	Banana Waterlily
Little Floatingheart	Blue Waterlily
European Frogbit	

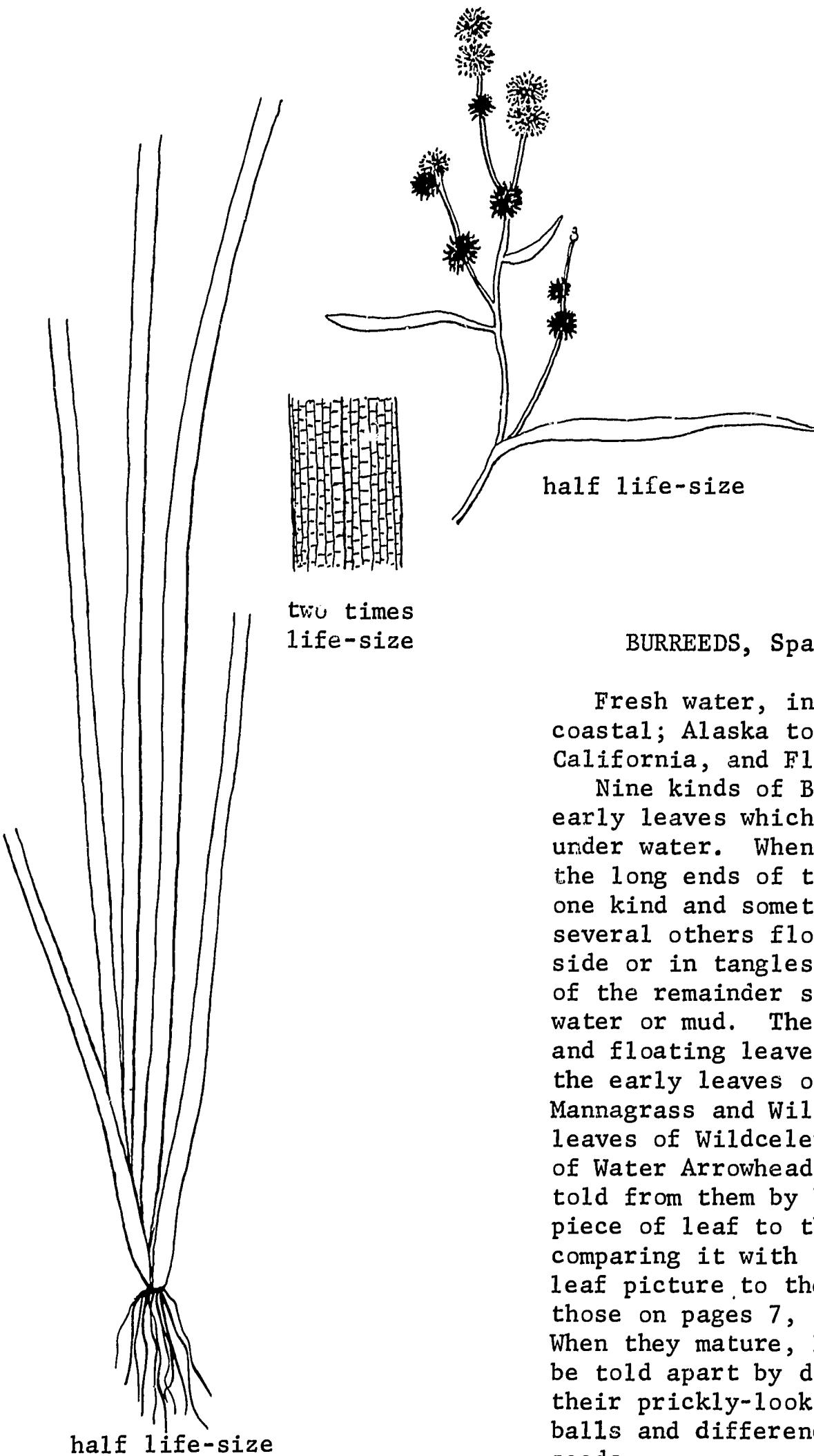
Group 11. Plants with coarse-toothed, lobed, or divided floating leaves; some kinds also growing partly out of water (pages 111-114)

Arctic Buttercup	Floating Buttercup
Marsileas	Lobb Buttercup
Ivyleaf Buttercup	Waterchestnut

Group 12. Little, free-floating plants (pages 115-118)

Star Duckweed	Ricciocarpus
Little Duckweeds	Water-velvets
Big Duckweeds	Eastern Wolffiella
Watermeals	Tongue Wolffiella
Riccia	

Group 1. PLANTS WITH LIMP, THREADLIKE TO RIBBONLIKE LEAVES COMING UP FROM THE BOTTOM OR FROM SHORT VERTICAL STEMS; SOMETIMES PARTLY FLOATING grow in fresh inland water and in fresh to salt coastal water. The leaves are upright or nearly so in deep water, trail under or on the surface in shallow water, and sometimes are exposed on mud at low tide. Except in very young plants, the leaves vary from several inches to several feet long. Flowers are often absent.



Fresh water, inland and coastal; Alaska to Greenland, California, and Florida.

Nine kinds of Burreed have early leaves which are limp and under water. When full-grown, the long ends of the leaves of one kind and sometimes those of several others float side by side or in tangles; the leaves of the remainder stand above water or mud. The underwater and floating leaves resemble the early leaves of Northern Mannagrass and Wildrice and the leaves of Wildcelery and a form of Water Arrowhead; but can be told from them by holding a piece of leaf to the light and comparing it with the piece-of-leaf picture to the left and those on pages 7, 10, and 21. When they mature, Burreeds can be told apart by differences in their prickly-looking seed balls and differences in their seeds.

The nine kinds are:

Sparganium americanum. Ontario to Newfoundland, Texas, and Florida. Mature leaves sometimes floating.

Sparganium androcladum. Minnesota to Quebec, Oklahoma, and Virginia.

Sparganium angustifolium (*Sparganium multipedunculatum* and *simplex*). Alaska to Greenland, California, New Mexico, Minnesota, and New Jersey. Mature leaves often floating.

Sparganium chlorocarpum. Alaska to Newfoundland, California, Iowa, and North Carolina.

Sparganium eurycarpum. British Columbia to Quebec, California, Kansas, and Virginia.

Sparganium fluctuans. British Columbia to Saskatchewan and Idaho; and Minnesota to Newfoundland and Pennsylvania. Mature leaves floating.

Sparganium glomeratum. Minnesota and Quebec. Mature leaves often floating.

Sparganium hyperboreum. Alaska to Greenland, Manitoba, and Nova Scotia. Mature leaves often floating.

Sparganium minimum. Alaska to Newfoundland, New Mexico, and Pennsylvania. Mature leaves sometimes floating.

NORTHERN MANNAGRASS, *Glyceria borealis*

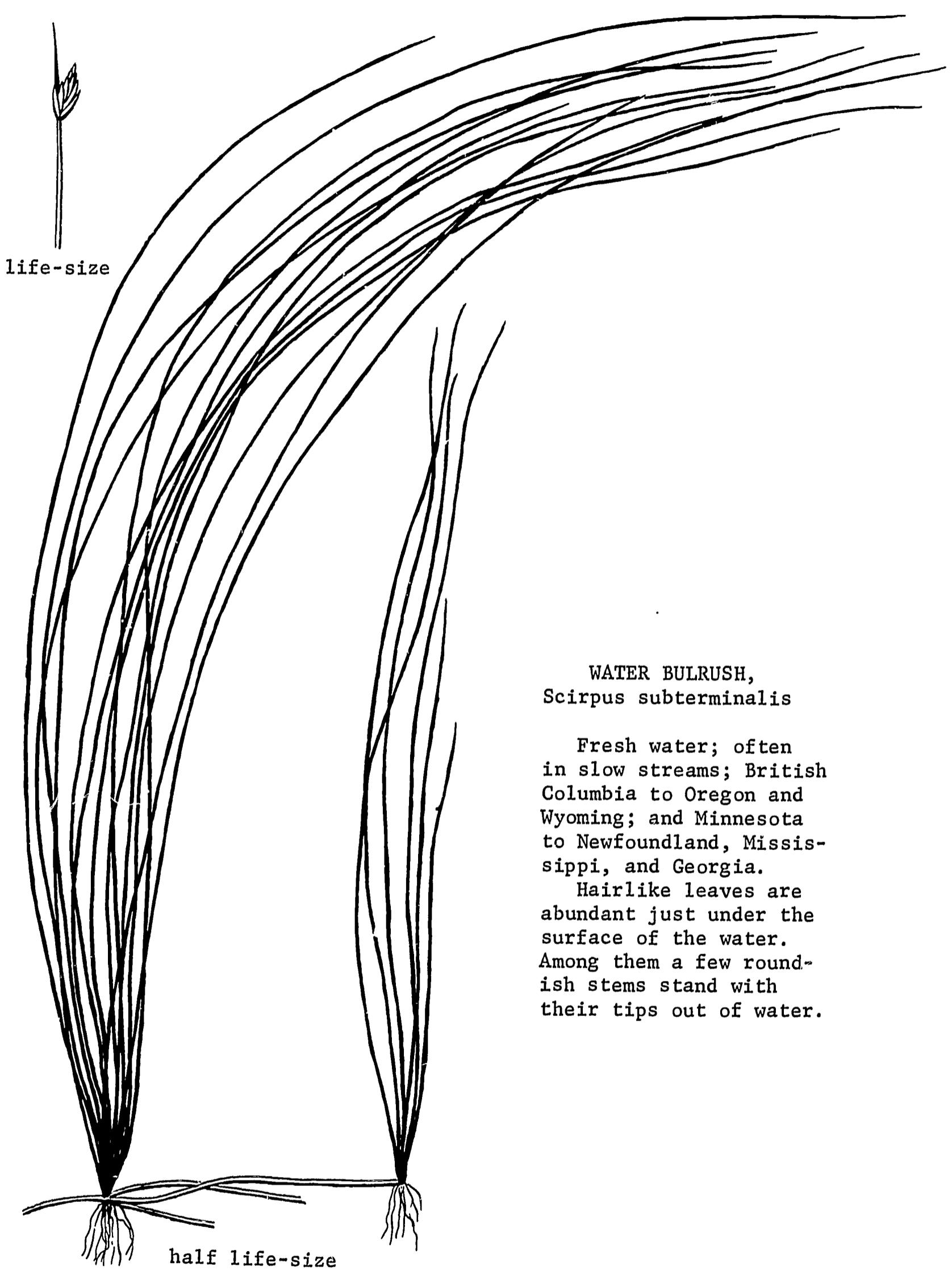
Fresh water; Alaska to Newfoundland, California, New Mexico, and Pennsylvania.

WILDRICE, *Zizania aquatica*

Fresh water, inland and coastal; Manitoba to Nova Scotia, Texas, and Florida; and rarely run wild from plantings in the Far West (Alberta to California).

Young plants of each kind have ribbonlike underwater leaves with long floating ends. These resemble the underwater and floating leaves of Burreeds and the leaves of Wildcelery and a form of Water Arrowhead; but can be told from them by holding a piece to the light and comparing it with the piece-of-leaf picture to the right and those on pages 6, 10, and 21. Mature plants have leafy stems which stand above water or mud.

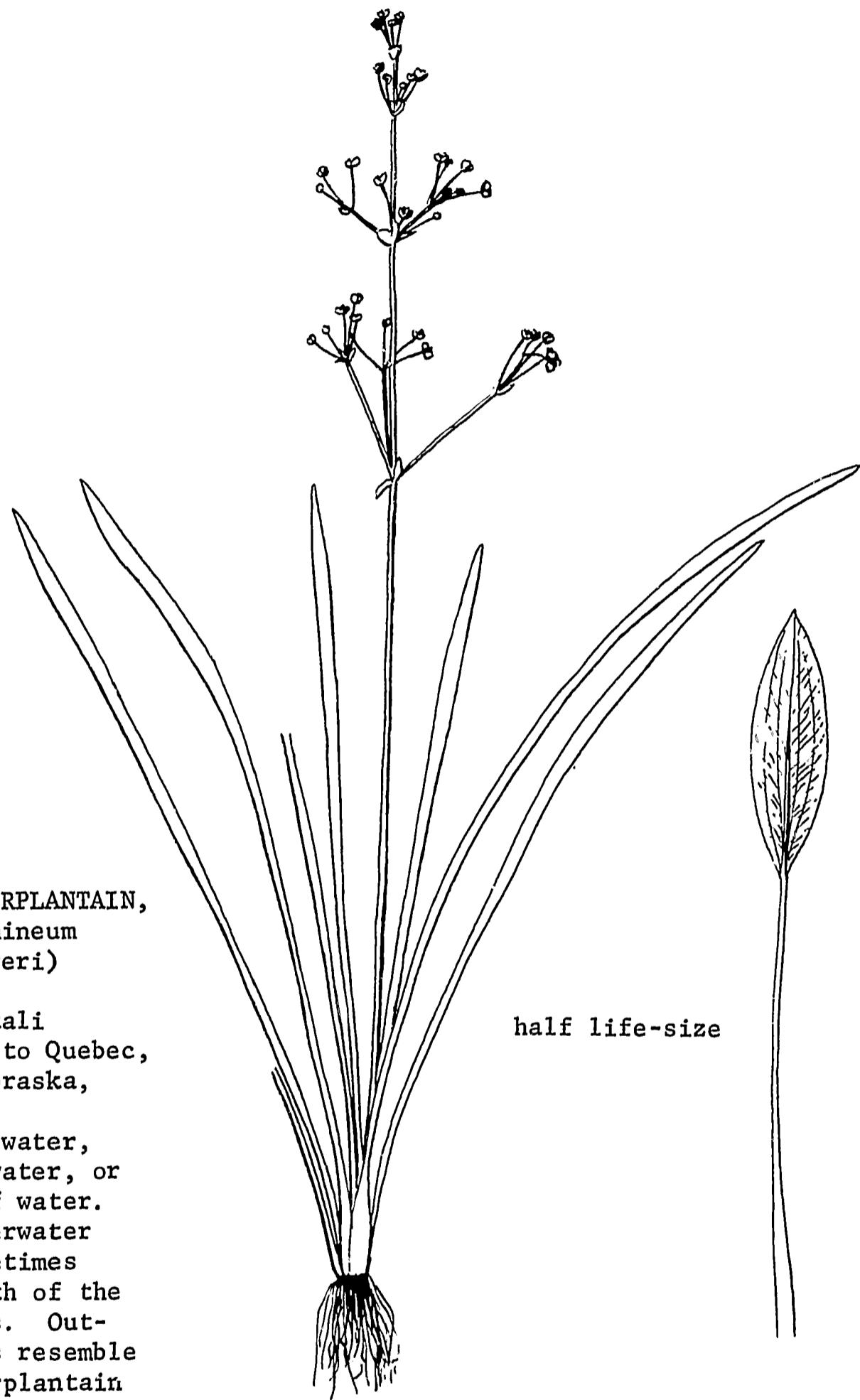
two times
life-size



NARROWLEAF WATERPLANTAIN,
Alisma gramineum
(*Alisma geyeri*)

Fresh or alkali
water; Alberta to Quebec,
California, Nebraska,
and Vermont.

Grows under water,
partly out of water, or
entirely out of water.
Ribbonlike underwater
leaves are sometimes
twice the length of the
flower clusters. Out-
of-water plants resemble
Broadleaf Waterplantain
(page 93); but the
leaves have a tapering
base, and the clusters
of flowers are often
shorter than the leaves.

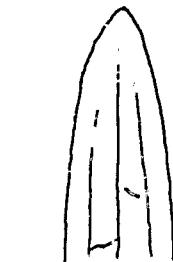
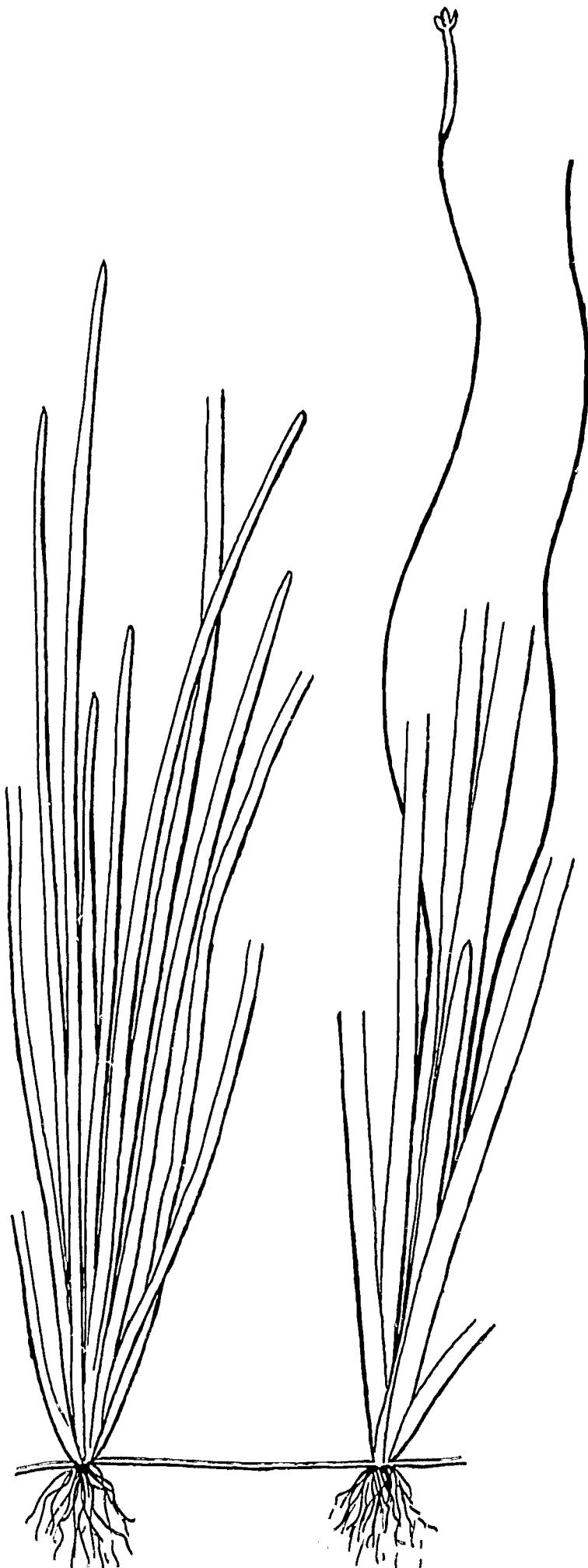


WILDECELERY,
Vallisneria americana
(*Vallisneria spiralis*)

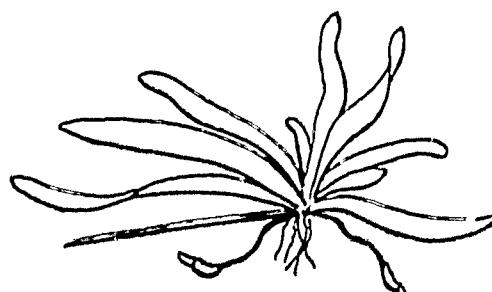
Fresh inland water and fresh to slightly brackish coastal water; Manitoba to Nova Scotia, Texas, and Florida; and rarely run wild from plantings in the Far West (Washington to Arizona).

Leaves, which are sometimes several feet long, have a fine-veined, light-colored center stripe. In summer the plants have long-stalked, cylindrical pods.

The leaves resemble those of a form of Water Arrowhead, the underwater and floating leaves of Burreeds, and the early leaves of Northern Mannagrass and Wildrice; but can be told from them by holding a piece of leaf to the light and comparing it with the piece-of-leaf picture to the left and those on pages 6, 7, and 21.



two times
life-size



half life-size

FLOWERING-RUSH,
Butomus umbellatus

Not pictured.

A native of Europe which was discovered along the tidal St. Lawrence River about 1900 and now grows in fresh water in Idaho; and Michigan to Quebec, Illinois, and Vermont.

Usually stands above shallow water or mud, with knee-high or higher narrow, upright leaves surrounding a stalk topped with a loose cluster of pink, 6-parted flowers. These are about 3/4 inch across.

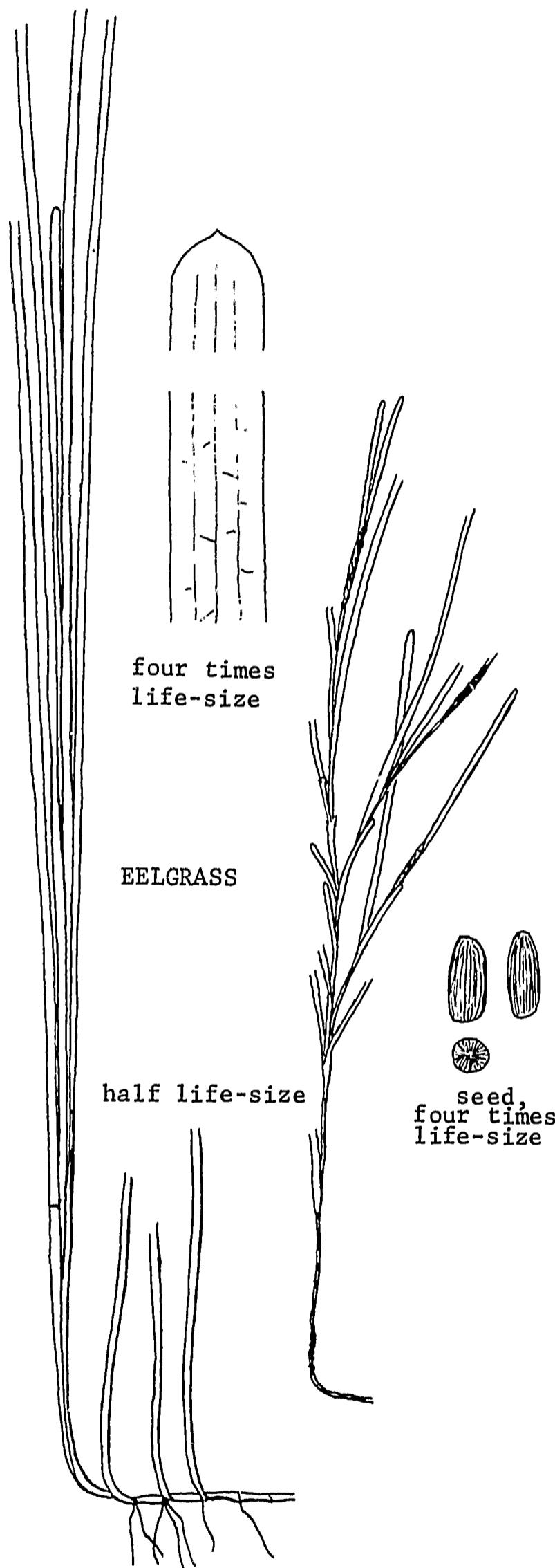
In deeper water, has only limp leaves which do not reach above the surface. These resemble the leaves of Burreeds and Wildcelery, but are usually narrower and less translucent and appear less veiny (see the piece-of-leaf pictures on pages 6 and 10).

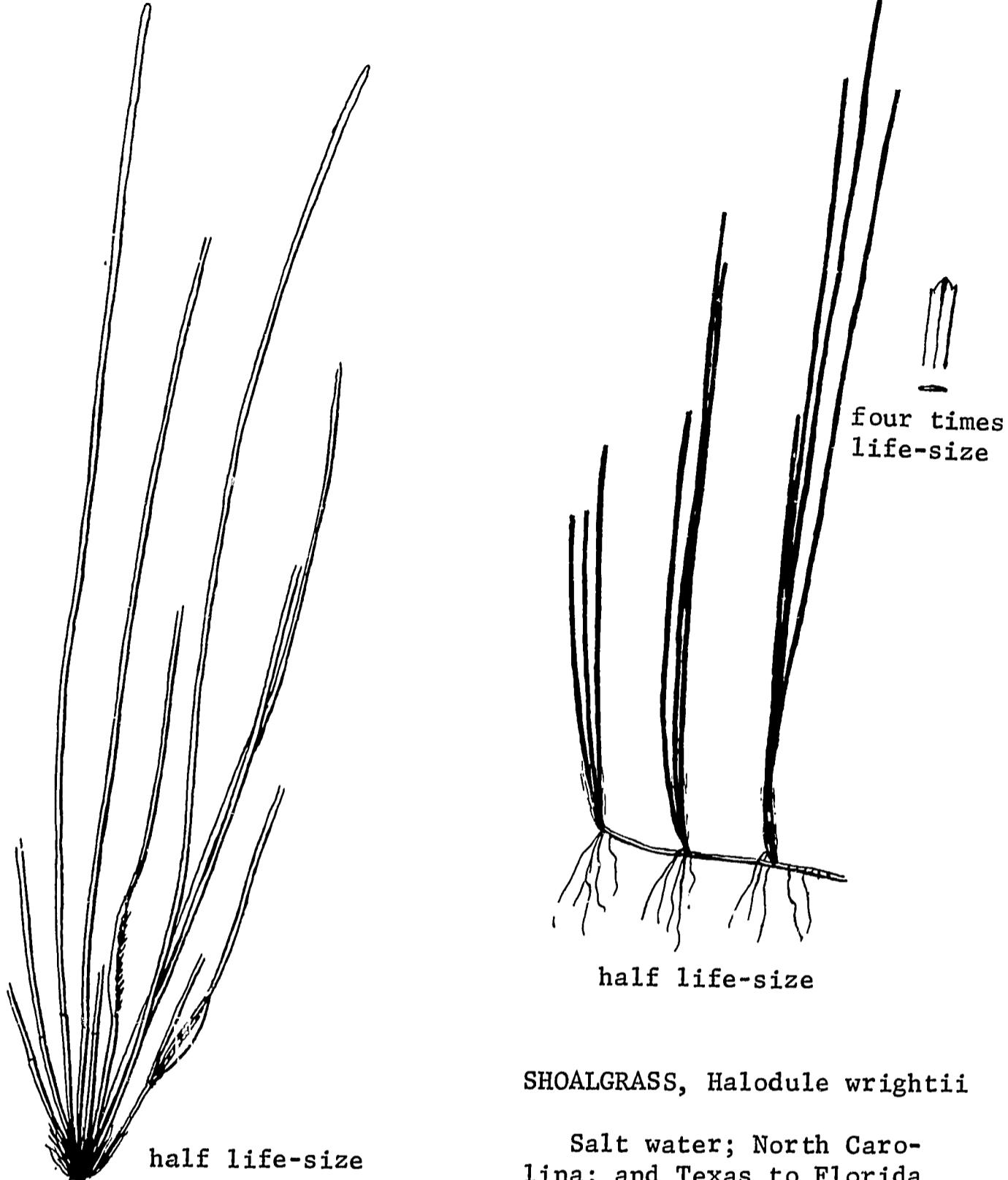
EELGRASS, *Zostera marina*

Salt water; Alaska to California; and Hudson Bay to North Carolina.

Often in dense beds in soft-bottomed bays. Some bays are so shallow that most of the water drains out at low tide; and for a while the ribbonlike foliage is left sprawling on the mud. Seeds are half-hidden in a long row in leaf sheaths.

Narrow-leaved plants resemble Shoalgrass (page 12), with which it grows in North Carolina; but Eelgrass leaves have a roundish tip.





SURFGRASS, *Phyllospadix scouleri*
(Phyllospadix torreyi)

Salt water; British Columbia
 to California.

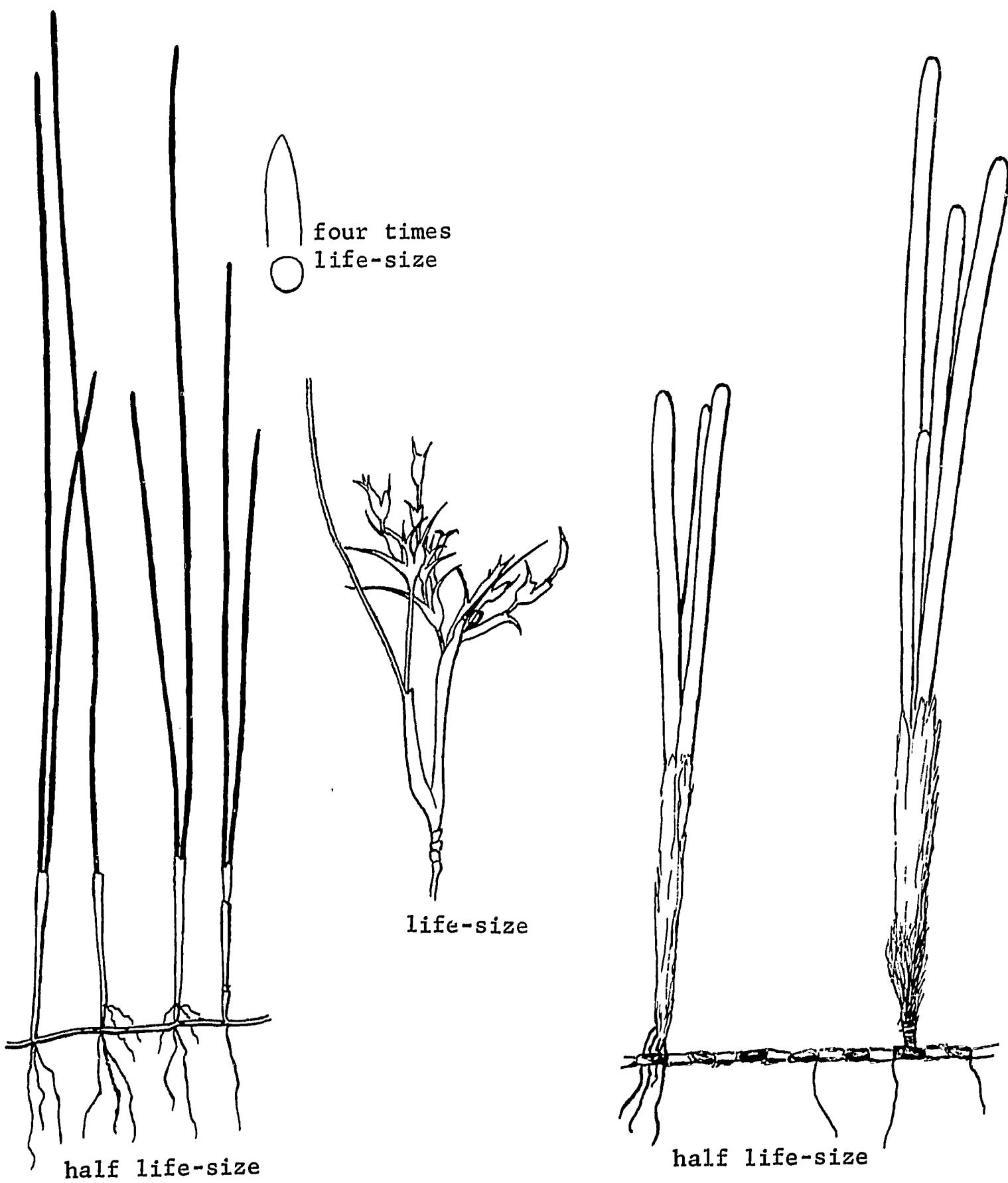
Flowers are sometimes in
 several clusters on a much longer
 stalk than the ones pictured.

SHOALGRASS, *Halodule wrightii*

Salt water; North Carolina;
 and Texas to Florida.

Leaves flat in cross-section.
 Flowers scarce.

Resembles narrow-leaved
 plants of Eelgrass (page 11),
 with which it grows in North
 Carolina; but has a 3-pointed
 leaf tip which could be mis-
 taken for a broken end. Re-
 sembles Manateegrass (page 13);
 but has flat leaves with a
 3-pointed tip.



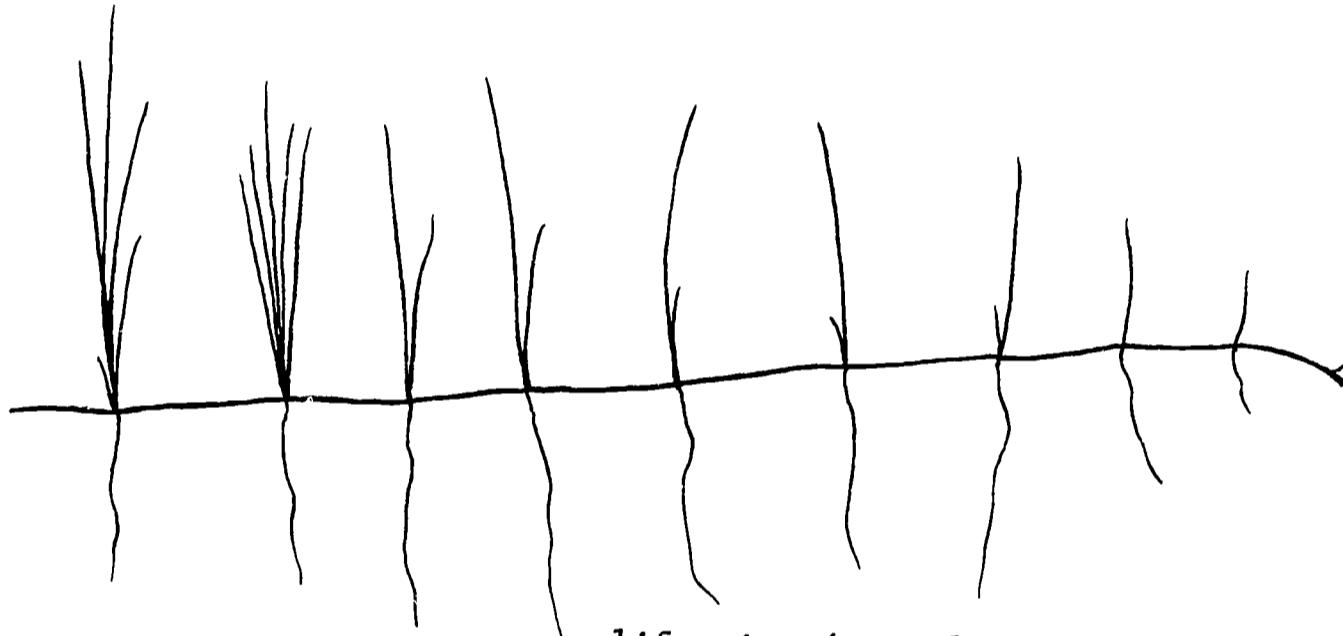
MANATEEGRASS, *Cymodocea manatoria*

Salt water; Texas to Florida.
Leaves round in cross-section.
Flowers common.
Resembles Shoalgrass (page 12);
but has round leaves with a blunt
tip.

**TURTLEGRASS,
*Thalassia testudinum***

Salt water; Texas
to Florida.

Group 2. PLANTS WITH RATHER STIFF, SHORT LEAVES OR LEAFLESS STEMS IN CLUMPS OR PATCHES ON THE BOTTOM; SOME KINDS SOMETIMES OUT OF WATER grow in fresh inland water and in fresh to salt coastal water. The leaves vary from upright to nearly horizontal, and usually are no more than a few inches long. Plants grow all the way to shore from depths of several feet. Flowers are often absent.



life-size (see also next page)

SLENDER SPIKERUSH, *Eleocharis acicularis*

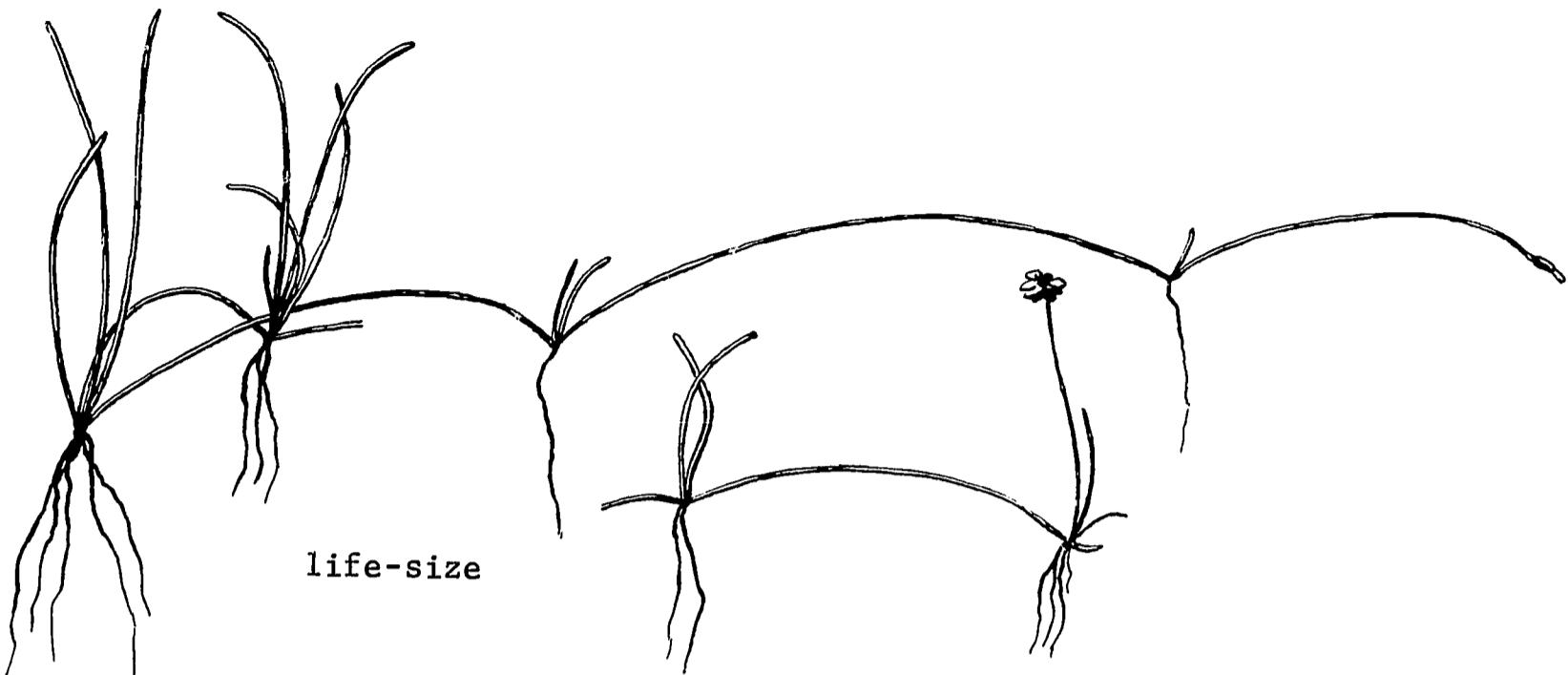
Fresh water; Alaska to Greenland, California, and Florida.

Usually on wet shores and in marshes, growing as a turf of fine green stems which, in summer, are topped with brown flower heads. Often under water, where the stems are longer and do not bloom. In streams, displaced rootstocks sometimes trail and produce still longer stems.

Resembles Dwarf Spikerush (page 23); but Slender Spikerush has thinner stems and is not known to produce tubers or to grow in brackish coastal marshes.



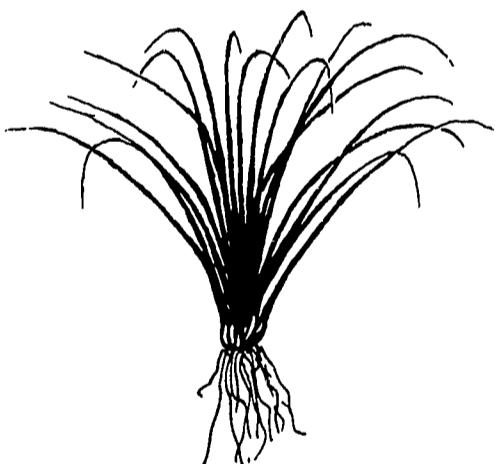
SLENDER SPIKERUSH, life-size
(see also preceding page)



CREEPING BUTTERCUP, *Ranunculus flammula*
(*Ranunculus reptans*)

Fresh water; Alaska to Greenland, California, New Mexico, Minnesota, and Pennsylvania.

Grows either under water or on wet shores. Leaves are connected by above-ground runners. Out-of-water plants have yellow flowers.



QUILLWORTS, *Isoetes*

Fresh inland water and fresh to slightly brackish coastal water; Alaska to Greenland, California, and Florida.

Quillworts resemble each other so much that they can be told apart only by using a microscope to look at the markings on spores pocketed in the base of leaves. Thirteen kinds vary considerably in size, number of leaves, and stiffness of leaves (sometimes they are long and limp); but some vary almost as much within themselves. Occasionally they grow partly or entirely out of water.

The thirteen kinds are:

Isoetes bolanderi. British Columbia to Alberta, California, Arizona, and Colorado.

Isoetes eatoni. New Hampshire to New Jersey.

Isoetes engelmanni. Missouri to New Hampshire, Alabama, and Georgia.

Isoetes flaccida. Georgia and Florida.

Isoetes foveolata. New Hampshire to Connecticut.

Isoetes howellii. Washington to Montana and California.

Isoetes macrospora. Minnesota to Newfoundland and Virginia.

Isoetes melanopoda (*Isoetes butleri*, *melanospora*, and *virginica*).

South Dakota to Virginia, Texas, and Georgia.

Isoetes muricata (*Isoetes braunii*). Alaska to Greenland, California, Colorado, Minnesota, and New Jersey.

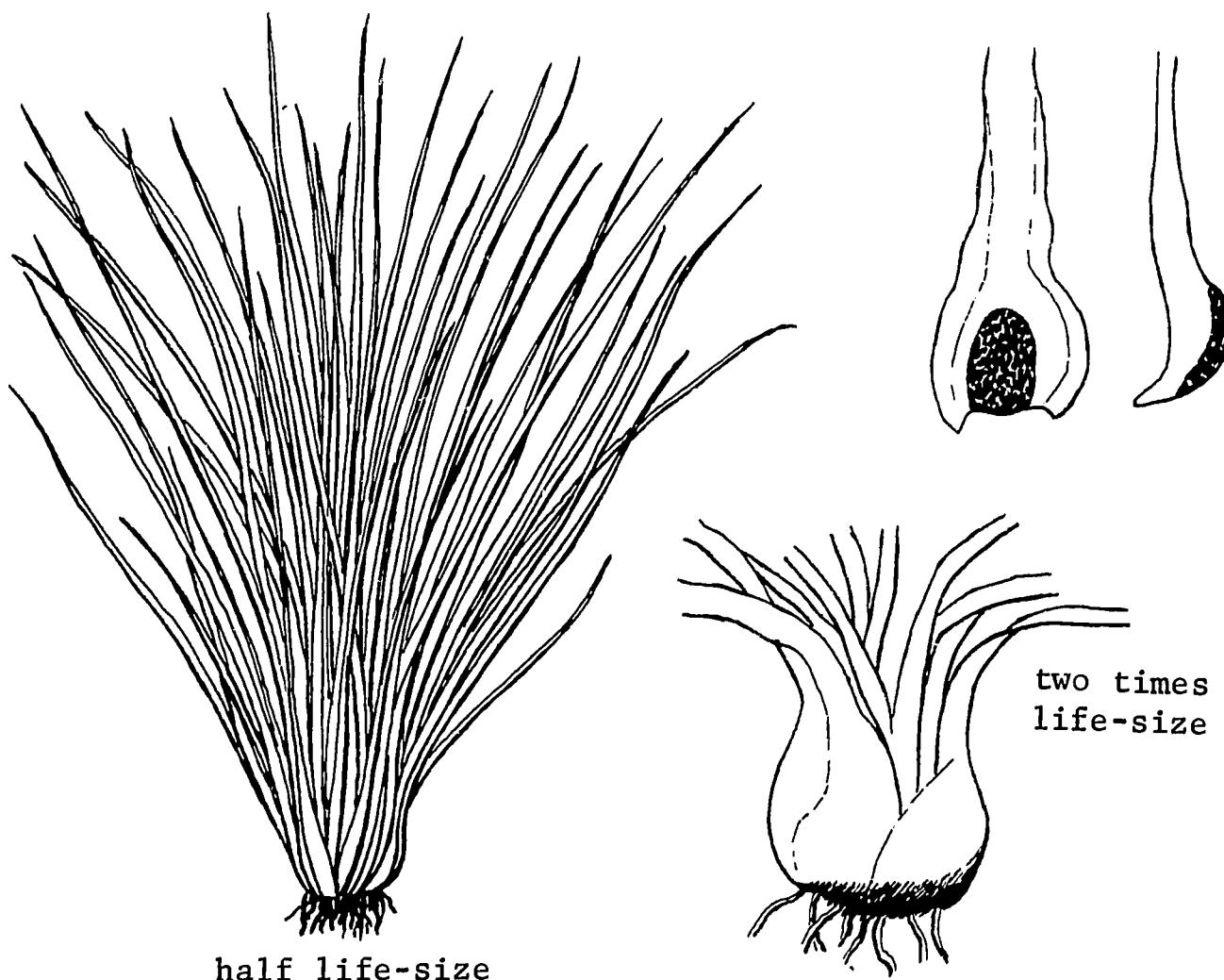
Isoetes nuttallii (*Isoetes orcuttii*). Washington to Idaho and California.

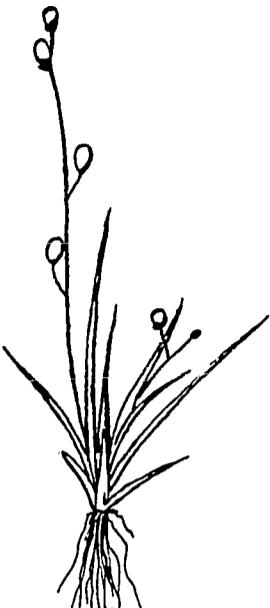
Isoetes occidentalis. Washington to Colorado and California.

Isoetes riparia (*Isoetes saccharata*). Michigan to Newfoundland and North Carolina.

Isoetes tuckermani. Quebec to Newfoundland, New York, and Connecticut.

The smaller Quillworts resemble *Littorella* (page 23) and *Pillwort* (page 28); but Quillwort leaves have a much-enlarged base, and clumps of leaves are not connected by rootstocks. The smaller Quillworts resemble *Pipeworts* (page 25); but Quillwort leaves taper only a little from the much-enlarged base, and their roots are not closely crosslined.





life-size

SUBULARIA, *Subularia aquatica*

Fresh water; Alaska to Quebec, California, Utah, Minnesota, and New York.

Has tiny white flowers and roundish pods, either under water or on wet shores.

Resembles the underwater form of Bog Rush (page 26); but the clumps of leaves are not connected by underground rootstocks, and plants often have flowers or seed pods.

ARROWHEADS, *Sagittaria*

Fresh water, inland and coastal; Alaska to Quebec, California, and Florida.

Young plants of five kinds of Arrowhead often grow under water as clumps of narrow, stalkless leaves. The leaves may be stiff or limp, short or ribbonlike, blunt-tipped or sharp-tipped, flat or as-thick-as-wide. When they mature, these Arrowheads can be told apart by their leaves and seeds.

The five kinds are:

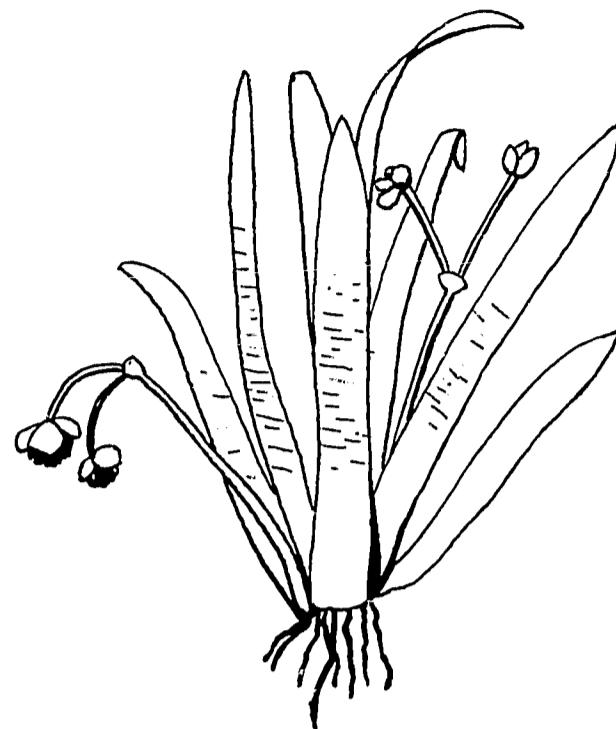
BUR ARROWHEAD, *Sagittaria rigida*. Not pictured. Manitoba to Quebec, Nebraska, Alabama, and Virginia.

HOODED ARROWHEAD, *Sagittaria calycina* (*Lophotocarpus calycinus* and *spongiosus*). California; and South Dakota to New Brunswick, New Mexico, Louisiana, and North Carolina. In coastal water it matures without much change in shape or size of leaves; and the foliage and flowers are often under water at high tide.

NORTHERN ARROWHEAD, *Sagittaria cuneata* (see pages 104 and 105).

SLENDER ARROWHEAD, *Sagittaria graminea* (*Sagittaria chapmanii*, *cristata*, *cycloptera*, *eatonii*, *isoetiformis*, *macrocarpa*, *teres*, and *weatherbiana*). South Dakota to Nova Scotia, Texas, and Florida.

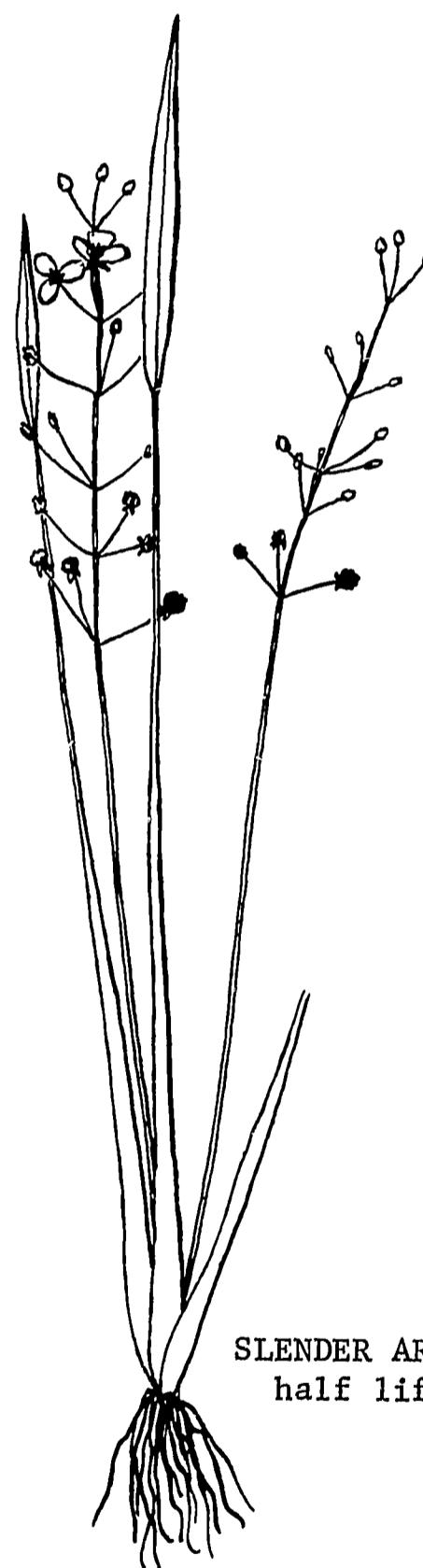
WATER ARROWHEAD, *Sagittaria subulata* (*Sagittaria filiformis*, *lorata*, and *stagnorum*). Maine to Alabama. In coastal water it matures without much change in shape or size of leaves; and the foliage and flowers are often under water at high tide. This form resembles *Limosella* (page 22); but Arrowhead clumps are connected by underground rootstocks and eventually produce 3-petaled flowers and balls of exposed seeds. Another form has a cluster of oval floating leaves which resemble some of the plants in Group 9. Still another has ribbonlike leaves which trail just under water. These leaves resemble those of Wildcelery, the underwater and floating leaves of Burreeds, and the early leaves of Northern Mannagrass and Wildrice; but can be told from them by holding a piece to the light and comparing it with the piece-of-leaf picture on page 21 and those on pages 6, 7, and 10.



HOODED ARROWHEAD
(small coastal plant),
life-size



SLENDER ARROWHEAD
(young plant), life-size



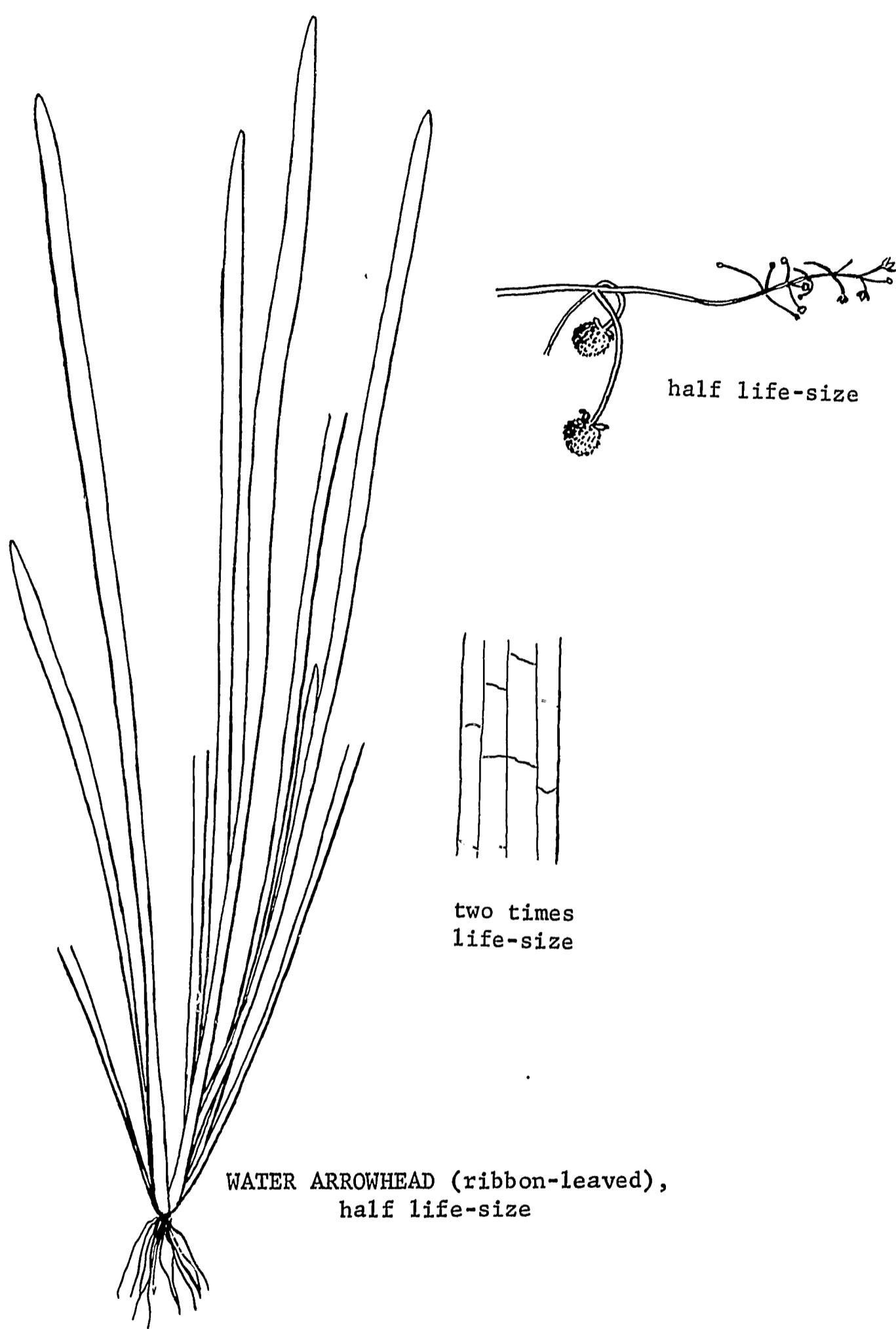
SLENDER ARROWHEAD,
half life-size

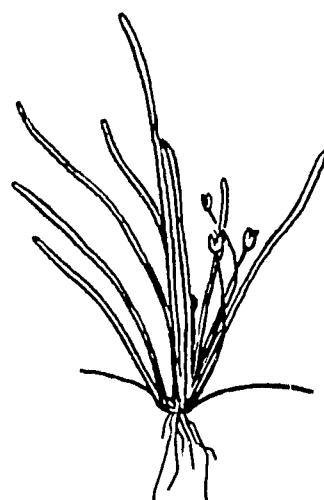


WATER ARROWHEAD (coastal plants),
life-size



WATER ARROWHEAD (floating-leaved),
half life-size





life-size

LIMOSELLA,
Limosella aquatica
(*Limosella acaulis* and *subulata*)

Fresh inland water and
fresh to brackish coastal water;
Northwest Territories to New-
foundland, California, New Mexico,
Missouri, and North Carolina (but
not inland east of the Missis-
sippi River).

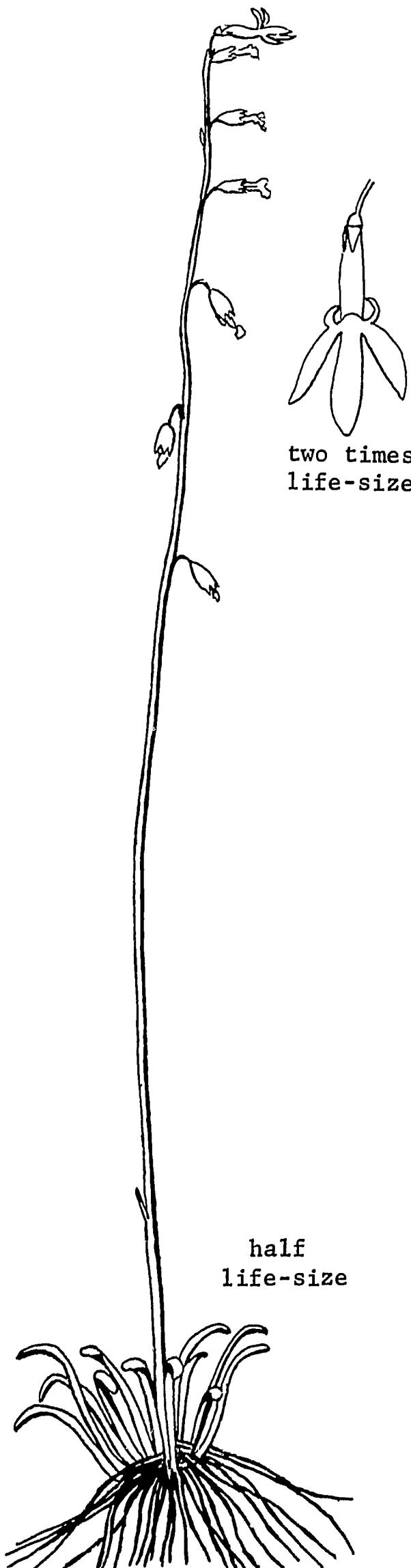
Along the coast, is under
water at high tide. Inland, has
long-stalked, oval leaves and
grows mainly on wet shores.

Resembles small plants of
Water Arrowhead (page 20); but
Limosella clumps are connected
by above-ground runners, and
they have tiny, 5-petaled
flowers and roundish pods.

WATER LOBELIA,
Lobelia dortmanna

Fresh water; British Co-
lumbia to Oregon; and Minnesota
to Newfoundland and New Jersey.

Leaves are under water or
out of water. Each leaf is
composed of two side-by-side
tubes. The lavender to white
flowers are out of water.

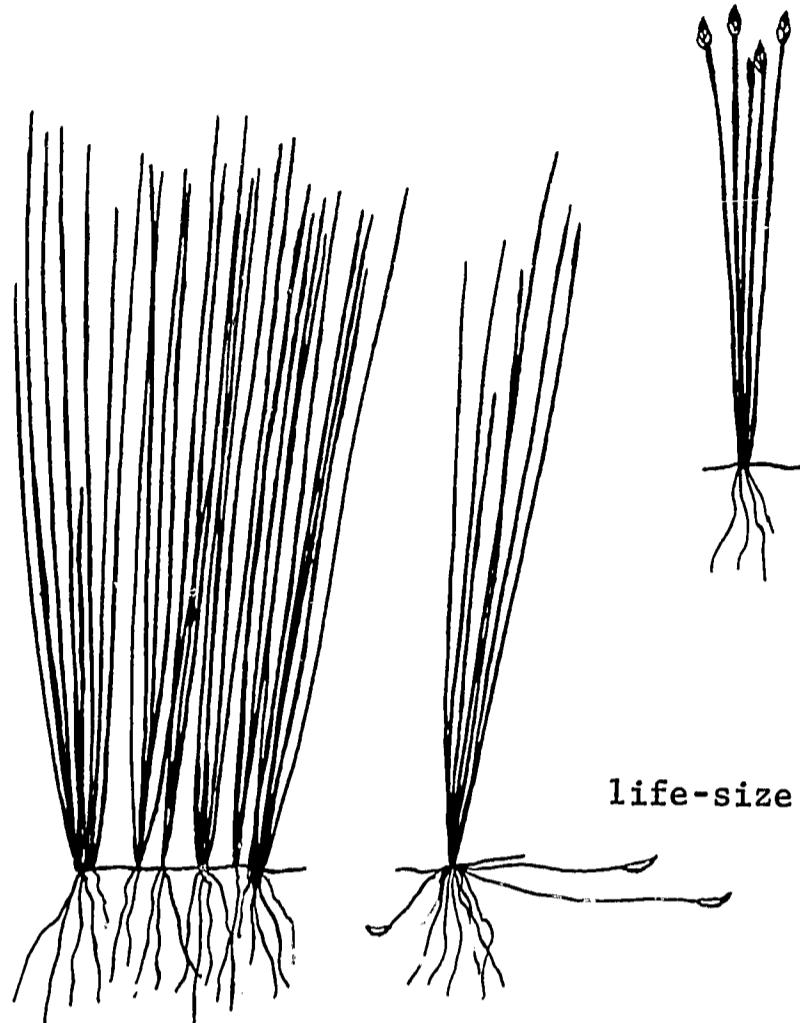


DWARF SPIKERUSH
Eleocharis parvula
(*Scirpus nanus*, *Eleocharis coloradoensis*)

Fresh, brackish, and alkali inland water and fresh to brackish coastal water; British Columbia to Newfoundland, California, and Florida (but very rare inland east of the Mississippi River).

Usually on wet shores and in marshes, growing as a turf of fine green stems which, in summer, are topped with green or brownish flower heads. Often under water in fresh to brackish pools and bays along the coasts, where the stems do not bloom. In summer and fall the rootstocks produce tiny tubers.

Resembles Slender Spikerush (pages 14 and 15); but has thicker stems, produces tubers, and is common in brackish coastal marshes.



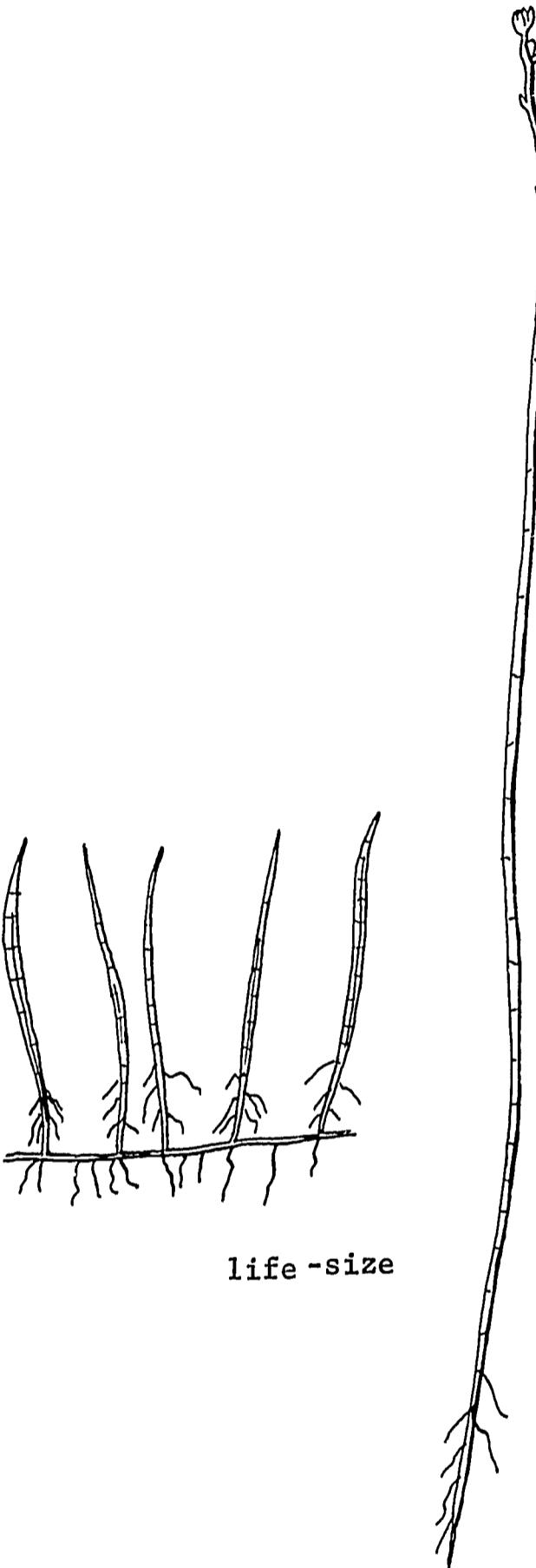
LITTORELLA,
Littorella uniflora
(*Littorella americana*)

Fresh water; Ontario to Newfoundland, Minnesota, and New York.

Grows in water to several feet deep, or on shore; but blooms only out of water.

Resembles small Quill-worts (page 16) and Pipe-worts (page 25); but the clumps are connected by rootstocks.





LEAFLESS WATERMILFOIL,
Myriophyllum tenellum

Fresh water; Minnesota to Newfoundland and Virginia.

Stems have a few, barely visible leaves. Flowers are on stems which stand above water.

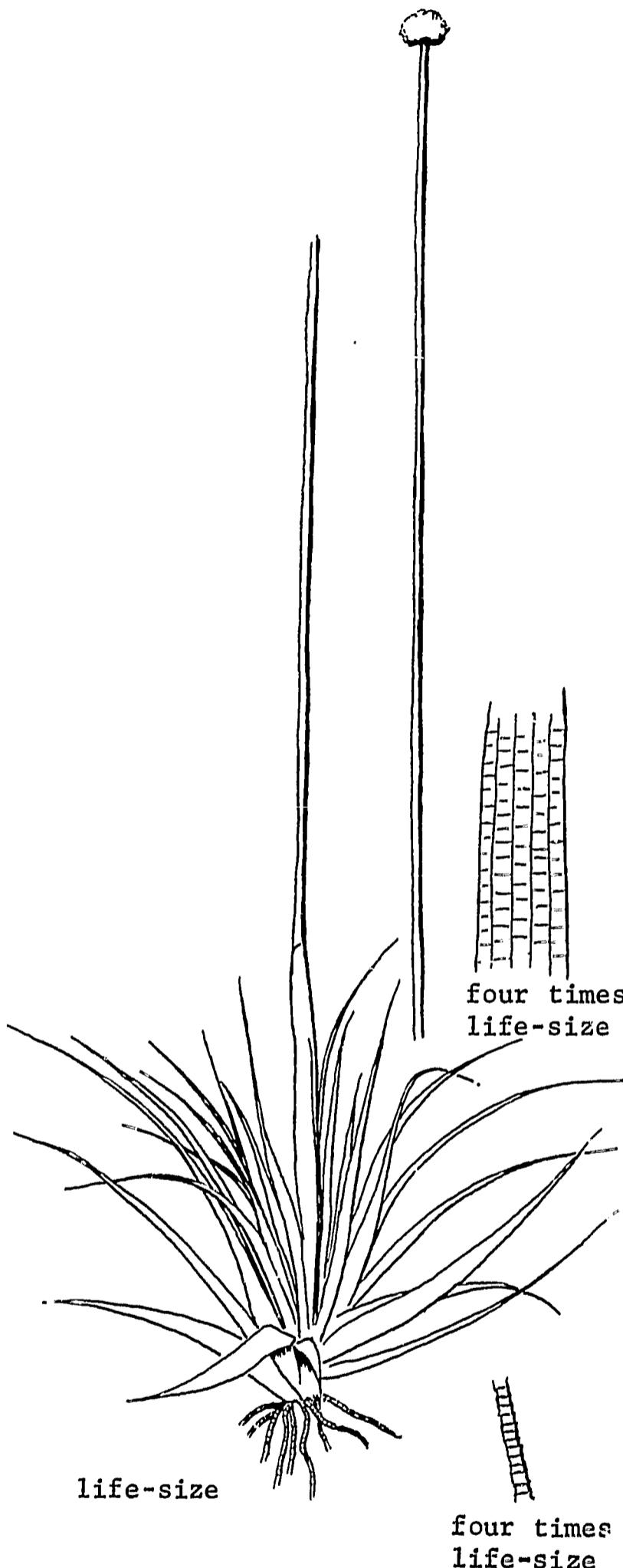
The Watermilfoils with featherlike underwater leaves are described on pages 31-42.

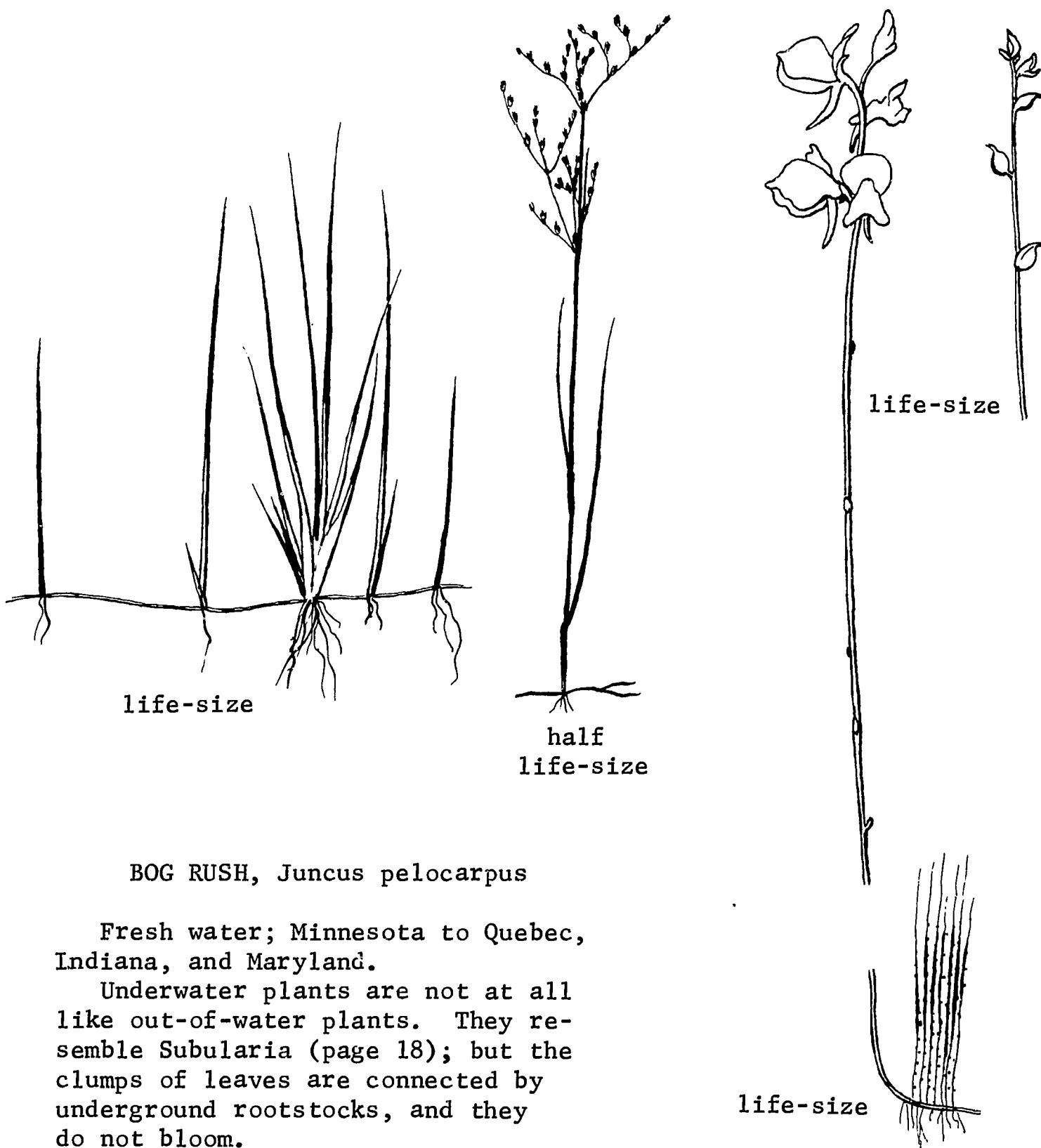
PIPEWORTS, *Eriocaulon*

There are two kinds of Pipewort which grow with leaves under water and flower heads sticking out, or with the whole plant out of water. Their thin leaves taper from a wide base to a threadlike tip and are checkerboarded with fine veins. Their roots have crosslines which make them look like tiny, whitish angleworms. They are:

EARLY PIPEWORT,
Eriocaulon compressum.
Fresh water; New Jersey to Texas. Leaves usually larger than those of Northern Pipewort, and heads usually maturing earlier.

NORTHERN PIPEWORT,
Eriocaulon septangulare
(*Eriocaulon lineare* and *parkeri*). Fresh water, inland and coastal; Minnesota to Newfoundland, Alabama, and Florida. Resembles *Littorella* (page 23), with which it often grows; but clumps of Pipewort leaves are not connected by rootstocks, and Pipewort roots are closely crosslined. Resembles the smaller Quillworts (page 16); but Pipewort leaves taper conspicuously from a wide base, and their roots are closely crosslined.





BOG RUSH, *Juncus pelocarpus*

Fresh water; Minnesota to Quebec, Indiana, and Maryland.

Underwater plants are not at all like out-of-water plants. They resemble *Subularia* (page 18); but the clumps of leaves are connected by underground rootstocks, and they do not bloom.

life-size

HORNED BLADDERWORT, *Utricularia cornuta* (*Utricularia juncea*; *Stomoisia cornuta*, *juncea*, and *virgatula*)

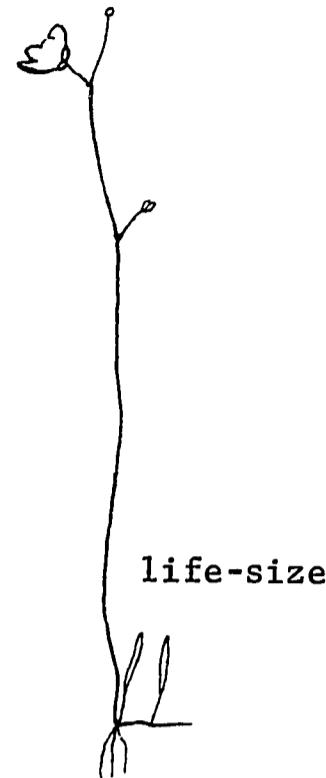
Fresh water; Minnesota to Newfoundland, Texas, and Florida (but not in the Middle Mississippi Valley).

Slim undivided leaves, fringed with speck-sized bladders, are half-buried in soil, either under water or out of water. They are likely to be overlooked until the turf beneath flowers is dug out and the soil carefully washed away. Flowers vary from big, open, and bright yellow to small and permanently budlike.

ZIGZAG BLADDERWORT,
Utricularia subulata
(*Setiscapella cleistogama* and
subulata)

Fresh water; Ontario to
Nova Scotia, Texas, and Florida.

Tiny undivided leaves are
half-buried in soil, either
under water or out of water.
They are likely to be overlooked
until the turf beneath flowers
is dug out and the soil care-
fully washed away. Speck-sized
bladders are on underground
branches. Flowers vary from
open and yellow to permanently
budlike.

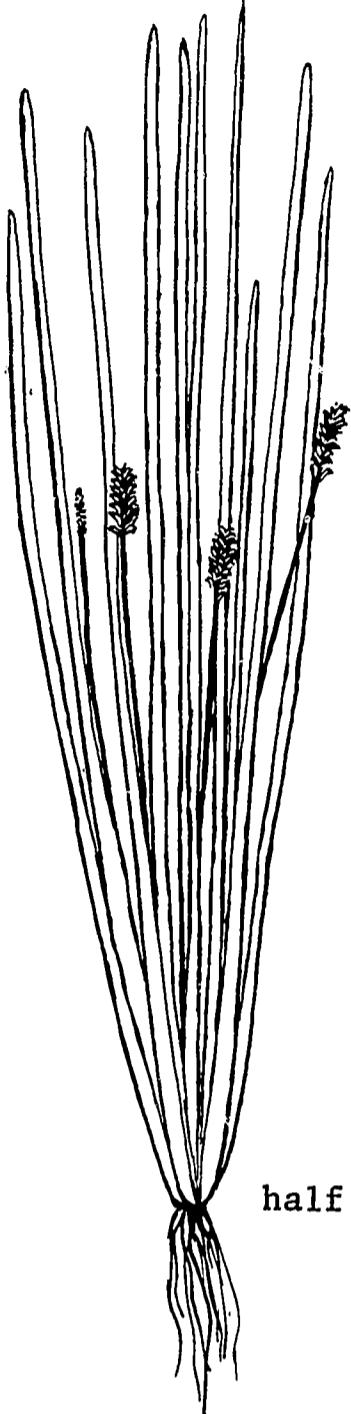


LAVENDER BLADDERWORT,
Utricularia resupinata
(*Lecticula resupinata*)

Fresh water; Wisconsin
to Nova Scotia, Indiana, and
Delaware; and Georgia and
Florida.

Slim undivided leaves,
fringed with a few speck-
sized bladders, are half-
buried in soil, either under
water or out of water. They
are likely to be overlooked
until the turf beneath flow-
ers is dug out and the soil
carefully washed away. Has
one lavender flower to a
stem.



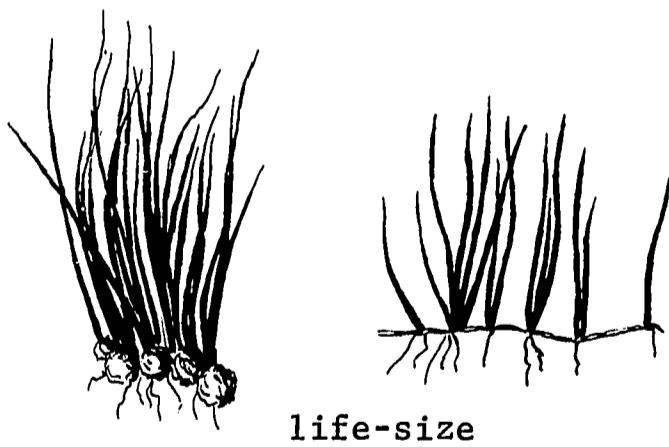


half life-size

**FLOWERING-QUILLWORT,
*Lilaea scilloides***

Fresh water; British Columbia to Alberta, California, and Montana (but commonest in central California).

Varies from one-quarter the height pictured to twice as high.



life-size

PILLWORT, *Pilularia americana*

In open-land depressions which contain water in the spring; Oregon and California; and Kansas to Georgia and Texas.

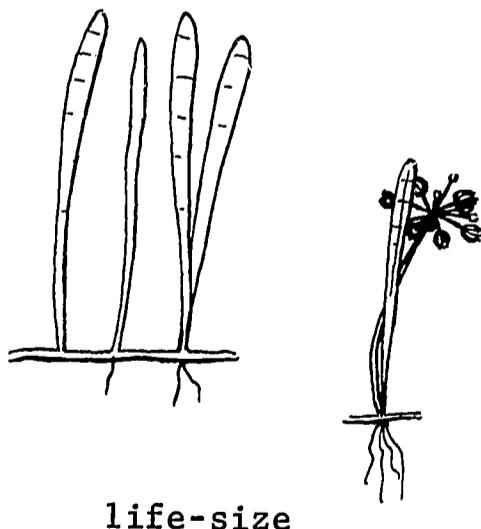
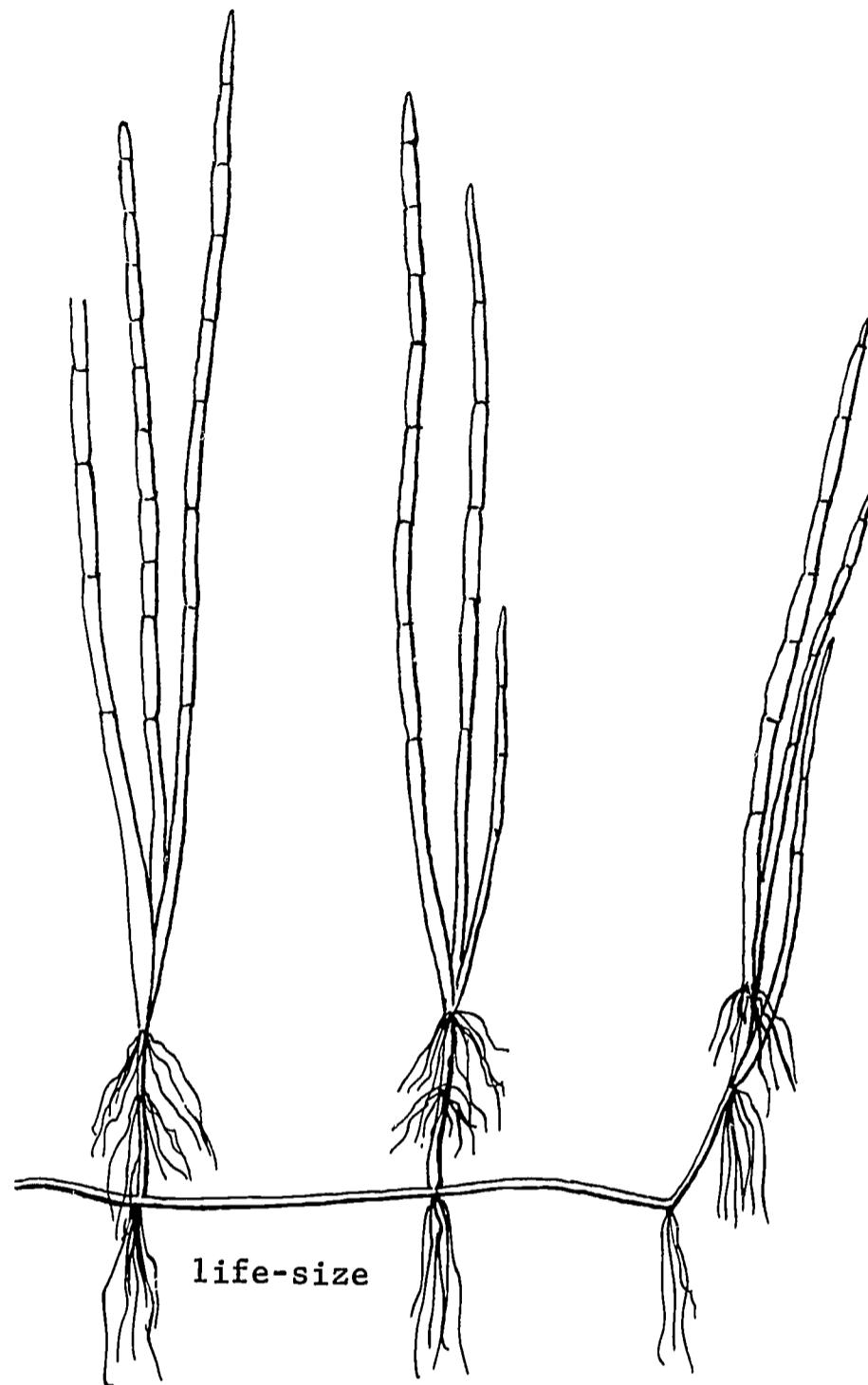
Leaf tips uncoil as they mature. Spores are borne in fuzzy balls at the base of leaves.

Resembles small Quillworts (page 16); but Pillwort clumps are connected by rootstocks, and Pillwort leaves do not have enlarged bases.

WESTERN LILAEOPSIS,
Lilaeopsis occidentalis

Fresh to brackish
coastal water; British
Columbia to California.

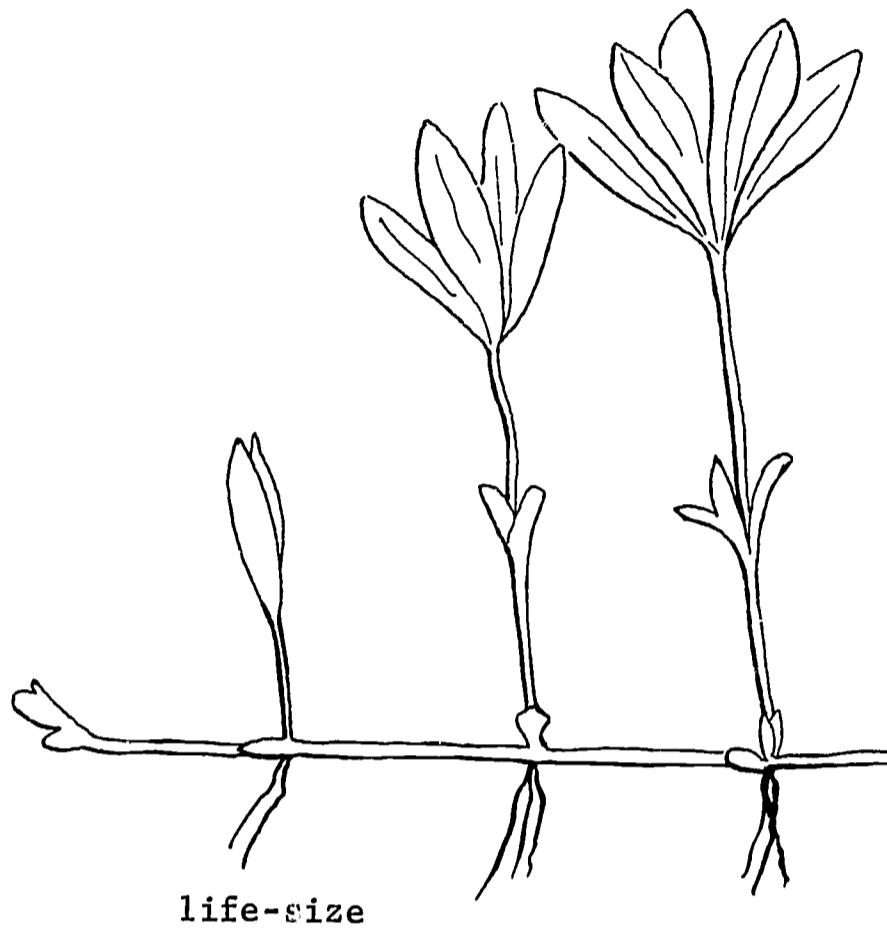
Under water at high
tide, out of water at
low. Leaves are hollow
and jointed. Flowers
are tiny and white.



EASTERN LILAEOPSIS, *Lilaeopsis chinensis*
(*Lilaeopsis lineata*)

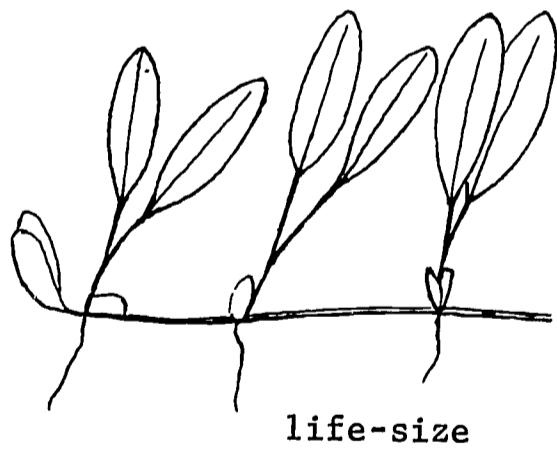
Fresh to brackish coastal water; Nova
Scotia to Louisiana.

Under water at high tide, out of
water at low. Leaves are hollow and
jointed. Flowers are tiny and white.



GULF HALOPHILA,
Halophila engelmanni

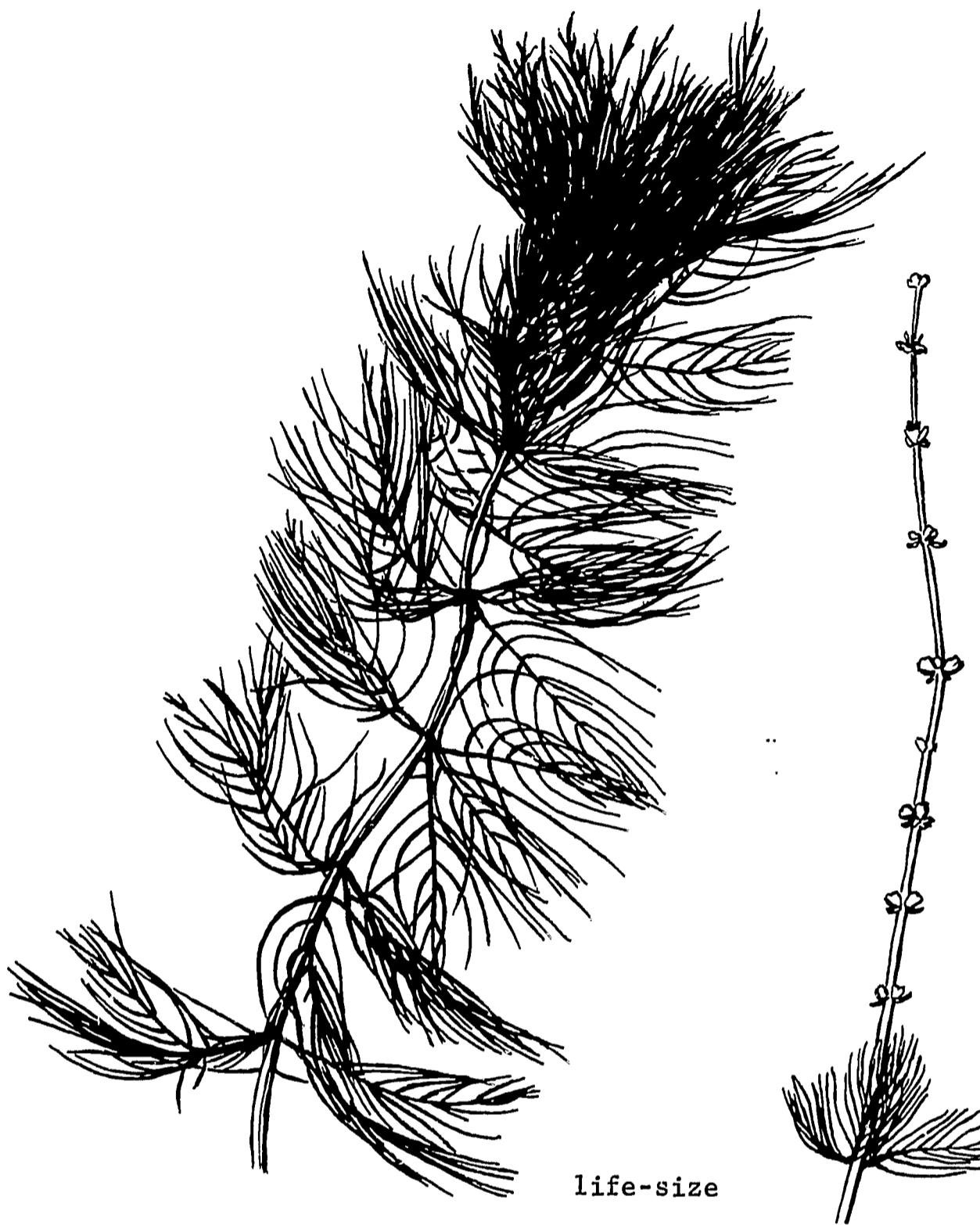
Salt water;
Florida and Texas.
Firm leaves are
stalkless or short-
stalked and have a
faint midvein.



CARIBBEAN HALOPHILA,
Halophila baillonis

Salt water; Florida.
Limp leaves are long-stalked
and have a conspicuous midvein.

Group 3. PLANTS WITH FEATHERLIKE, USUALLY LIMP LEAVES ON FLEXIBLE UNDERWATER STEMS; STEM TIPS OFTEN STICKING OUT OF WATER
grow in fresh inland water and in fresh to brackish coastal water. The stems vary from upright to horizontal and from a foot long to several feet; and they are usually branched. The underwater leaves usually collapse when taken out of water. At low tide, Eurasian Watermilfoil reaches the surface in a tangle of horizontal stems. When water levels drop in summer, several other kinds make a similar tangle; and a few produce short out-of-water stems. Most Watermilfoils are hard to tell apart when they don't have flowers or seeds. When in bloom, most of them have tiny brownish flowers in spikes which stand above the water. When the seeds are ripe, the spikes are usually lying in water. The seeds are partly joined to each other in fours. The largest kinds are only a little more than 1/16 inch long.

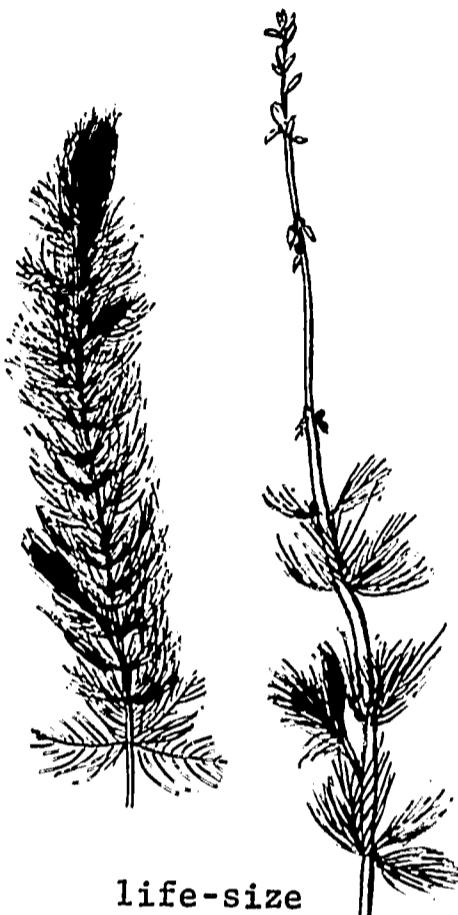


NORTHERN WATERMILFOIL, *Myriophyllum exalbescens*
(*Myriophyllum magdalenense*)

Fresh water, inland and rarely coastal; Alaska to Baffin Island, California, Kansas, and Pennsylvania.

Leaves often not collapsing when taken out of water, and often coated with lime.

Resembles Whorled (page 34), Eurasian (page 38), and Little (page 33) Watermilfoils, with which it sometimes grows. Its joints are farther apart than those of Whorled; therefore the usually buff or pinkish stems are not hidden by leaves. Its leaves have fewer, wider-spaced leaflets than those of Eurasian. Its stems and leaves are usually twice as large as those of Little.

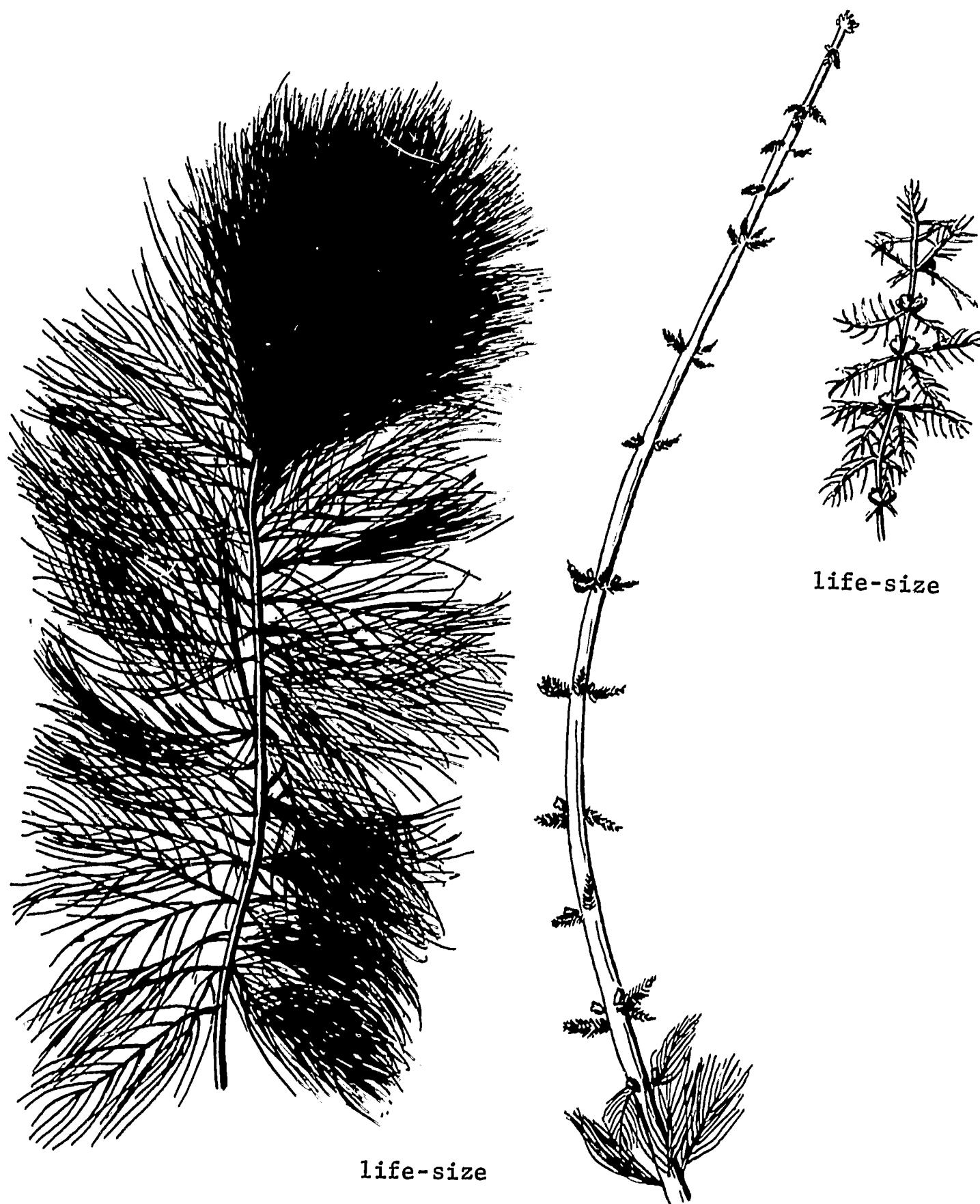


LITTLE WATERMILFOIL, *Myriophyllum alterniflorum*

Fresh water, inland and rarely coastal; Alaska to Newfoundland, Wisconsin, and Connecticut.

The leaves are so small and close together that a person has to look closely to be sure they are featherlike.

Resembles Northern (page 32) and Whorled (page 34) Watermilfoils; but stems and leaves are usually no more than half the size of theirs, and upper flowers are scattered instead of in whorls.



WHORLED WATERMILFOIL, *Myriophyllum verticillatum*

Fresh water, inland and rarely coastal; Alaska to Newfoundland, California, Illinois, and New Jersey.

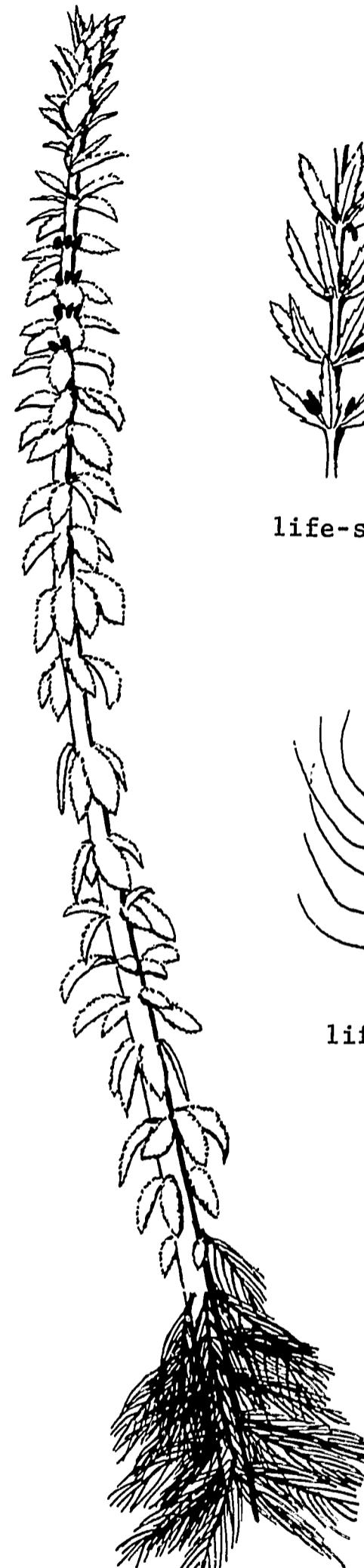
Stems usually green and almost hidden by leaves. During low water in summer, patches of short out-of-water stems sometimes grow on mud.

Resembles Northern (page 32), Eurasian (page 38), Little (page 33), and Farwell (page 36) Watermilfoils, with which it sometimes grows. Its joints are closer together than those of Northern; therefore its usually green stems are nearly hidden by leaves. Its leaves have fewer leaflets than those of Eurasian. Its stems and leaves are usually twice as large as those of Little. Its out-of-water flowers contrast with Farwell's underwater ones.

VARIABLE WATERMILFOIL,
Myriophyllum heterophyllum
(*Myriophyllum hippuroides*)

Fresh water; British Columbia to New Brunswick, California, and Florida.

Stems, stouter than in most other Watermilfoils, are thickly covered with limp leaves. Spikes, also stouter than in most of the others, are usually thickly covered with firm, oval to linear leaves.



life-size

life-size

life-size



life-size



two times
life-size

FARWELL WATERMILFOIL,
Myriophyllum farwellii

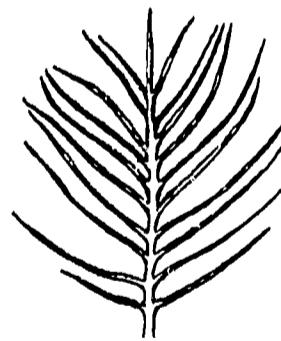
Fresh water; Minnesota to Nova Scotia and Vermont.

Flowers all at the base of underwater leaves, not in out-of-water spikes.

Resembles Whorled Watermilfoil (page 34), with which it sometimes grows; but Farwell's flowers are at the base of underwater leaves.



half life-size

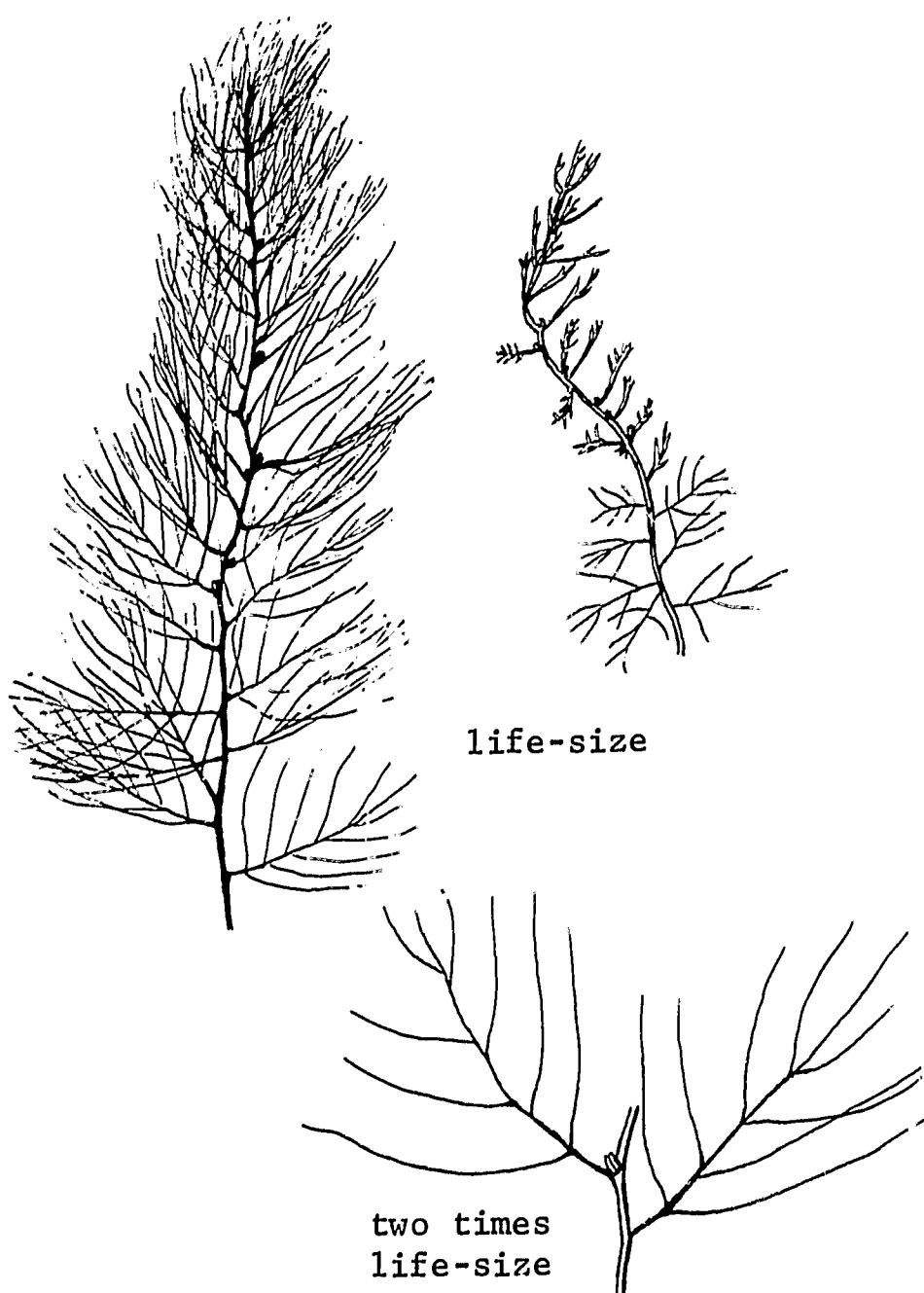


life-size

MARSH MERMAIDWEED,
Proserpinaca palustris
(*Proserpinaca amblyogona* and
platycarpa)

Fresh water; Wisconsin to Nova Scotia, Texas, and Florida.

From fall to early spring, stems of the preceding year send out underwater stems with foliage resembling that of Northern Watermilfoil (page 32), except that there is only one leaf at a joint. By mid-spring, stem tips with toothed leaves reach out of water. In summer, the whole plant is often out of water and there is a three-cornered seed at the base of many of the leaves.

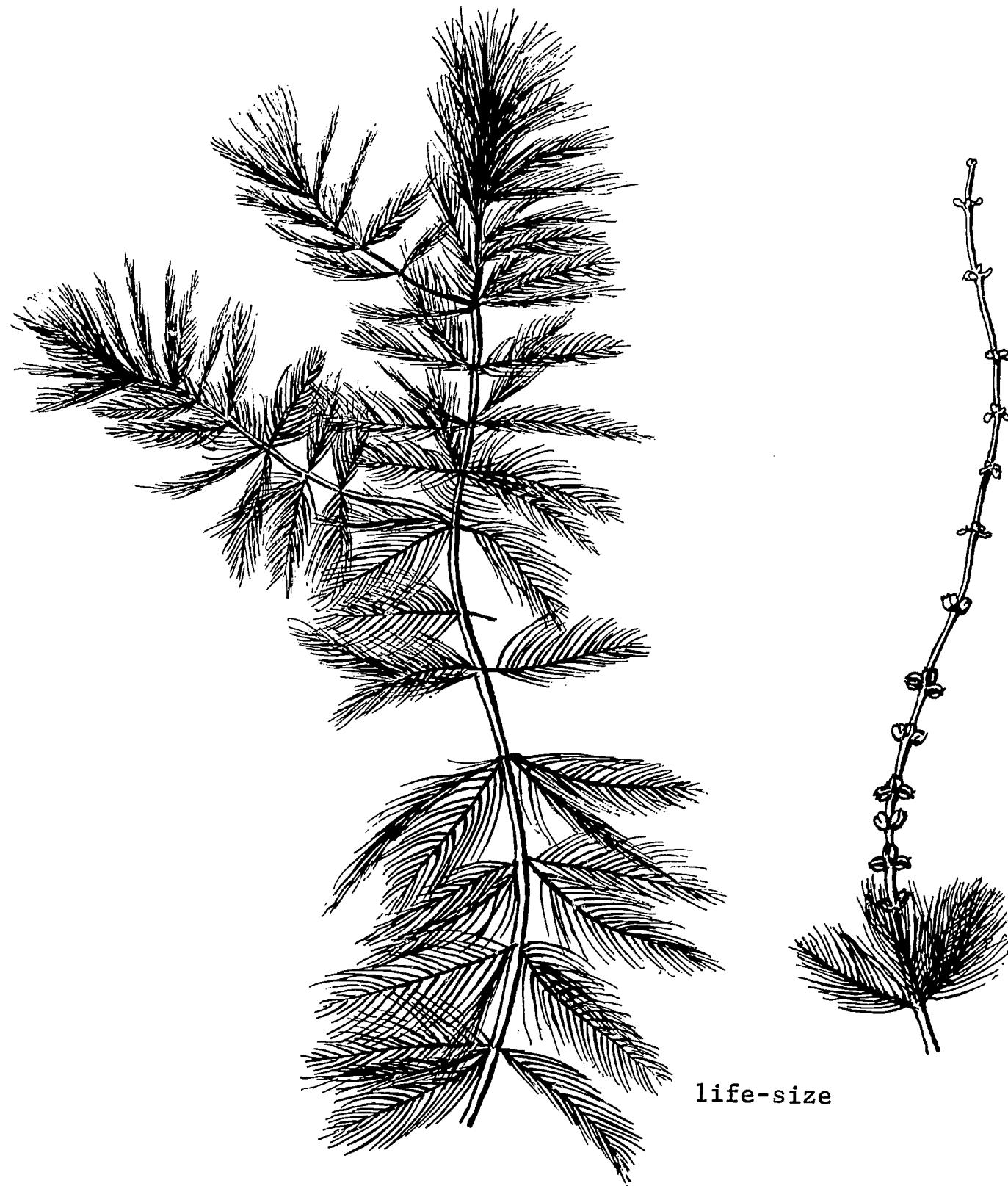


LOW WATERMILFOIL, *Myriophyllum humile*

Fresh water, inland and rarely coastal; Nova Scotia to North Carolina.

Stems thinly covered with very fine, limp leaves; their tip sometimes out of water and bearing small, firm, slightly-divided or undivided leaves. Usually there is only one out-of-water leaf at a joint. Flowers are at the base of either underwater leaves or out-of-water leaves. During low water in summer, patches of short out-of-water stems sometimes grow on mud.

Foliage on underwater stems resembles that of Eastern Watermilfoil (page 40), with which it sometimes grows; but Low Watermilfoil has smooth-backed seeds which are $1/32$ inch long or a little more--so tiny that they are easily overlooked.



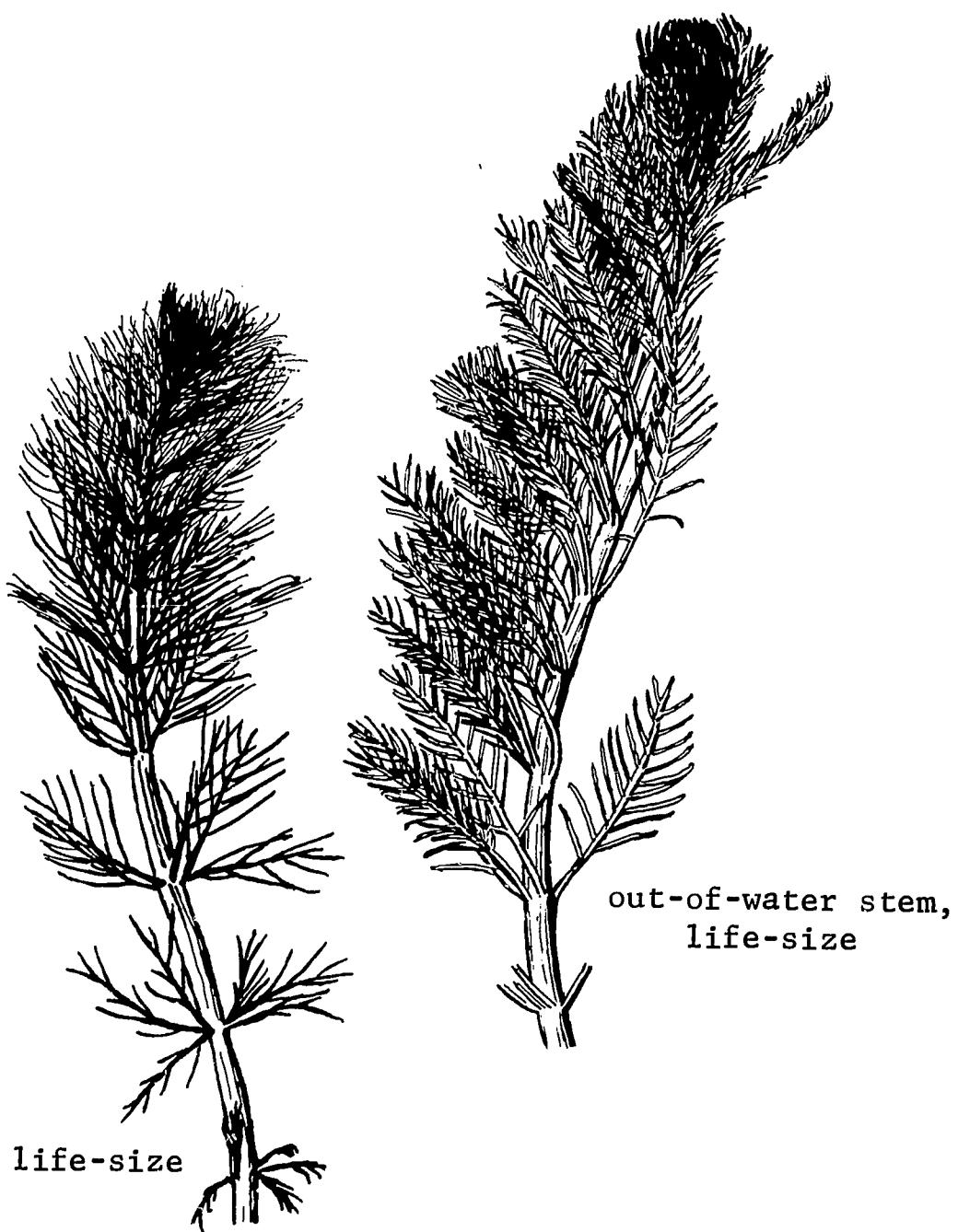
EURASIAN WATERMILFOIL, *Myriophyllum spicatum*

Fresh inland water and fresh to brackish coastal water; California; and Wisconsin to Vermont, Texas, and Florida.

This plant has been in the United States for at least seventy years. Since 1955 it has become very abundant in Upper Chesapeake Bay, the tidal Potomac River, and several Tennessee Valley reservoirs.

Leaves look like weatherbeaten feathers because of their 12-16 pairs of close-together leaflets.

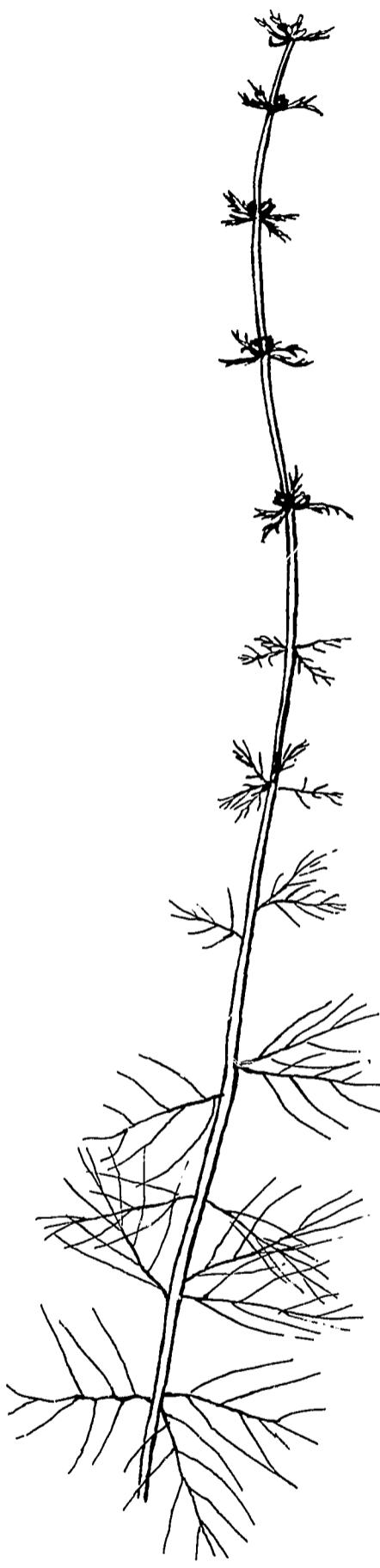
Resembles Northern (page 32) and Whorled (page 34) Watermilfoils, with which it sometimes grows; but can be told from them by its more featherlike leaves.



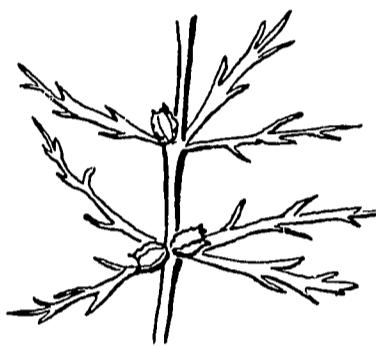
PARROTFEATHER, *Myriophyllum brasiliense*
(*Myriophyllum proserpinacoides*)

A native of South America which is a common aquarium plant and which has run wild in fresh water from Idaho to California and Arizona; and Kansas to New York, Texas, and Florida.

Differs from other Watermilfoils in having firm, grayish-green foliage which pushes a few inches out of water. Has some underwater branches with limp leaves.



life-size



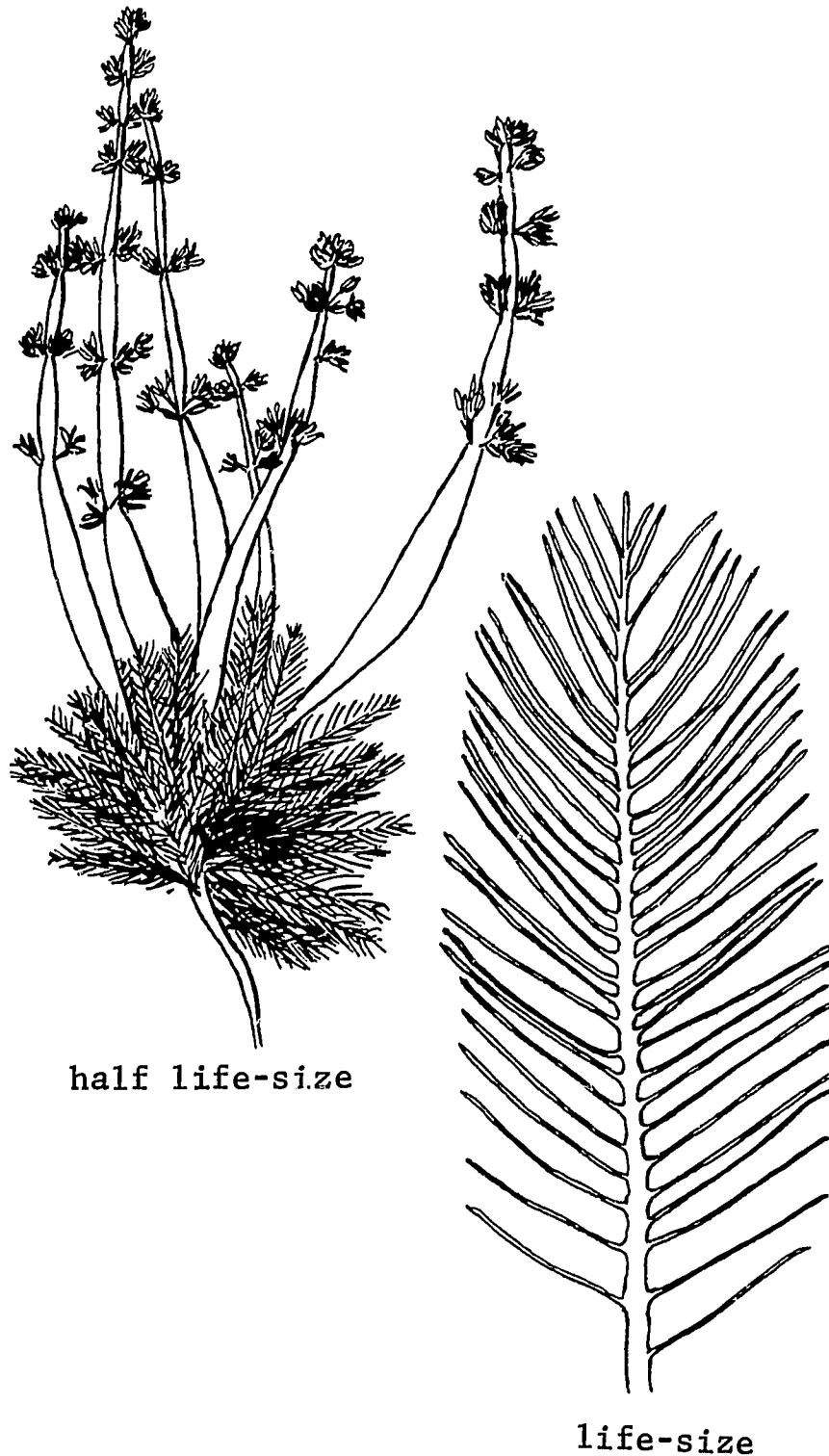
two times
life-size

EASTERN WATERMILFOIL,
Myriophyllum pinnatum

Fresh water, inland and coastal;
Iowa to Massachusetts, Texas, and
Florida.

Stems thinly covered with very fine,
limp leaves; their tip often out of
water and bearing small, firm, slightly-
divided leaves. Out-of-water leaves
usually clustered at joints and with
a flower at their base. During low
water in summer, patches of short out-
of-water stems sometimes grow on mud.

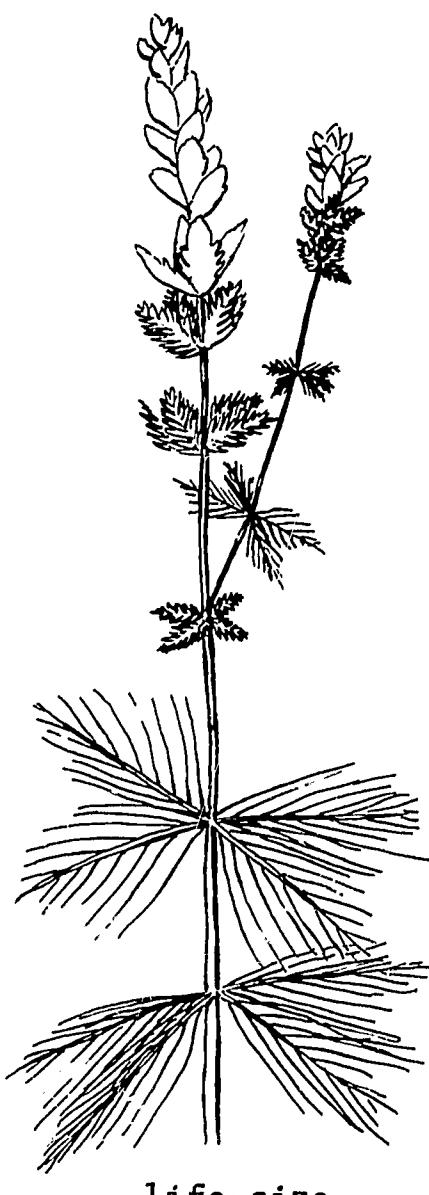
Foliage on underwater stems resem-
bles that of Low Watermilfoil (page 37),
with which it sometimes grows; but
Eastern has rough-backed seeds which
are $1/16$ inch long.



FEATHERFOIL, *Hottonia inflata*

Usually in pools in freshwater swamps; Missouri to Maine, Texas, and Florida.

Comes up from seed in the fall; and from fall to spring the leaves are bunched toward the tip of unbranched stems, just below the surface of the water. Usually is overlooked until clusters of swollen flower stalks grow above water in spring and early summer.

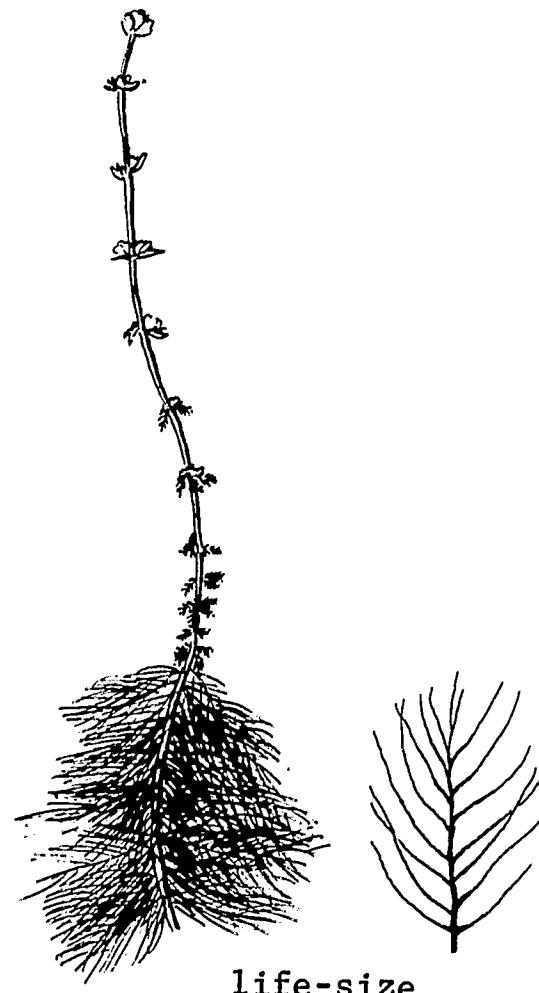


life-size

ANDEAN WATERMILFOIL,
Myriophyllum elatinoides

A native of South America and New Zealand which has run wild in the Deschutes River near Bend, Oregon.

Out-of-water leaves grayish-green. Midvein of underwater leaves tapering from base to tip.



life-size

SOUTHERN WATERMILFOIL,
Myriophyllum laxum

Fresh water; North Carolina to Alabama.

Resembles Whorled Watermilfoil (page 34) which has not been found south of New Jersey. Resembles Variable Watermilfoil (page 35); but has slimmer stems and nearly leafless spikes.

Group 4. PLANTS WITH FINE-FORKED, LIMP LEAVES MIXED WITH SMALL ROUNDISH BLADDERS ON FLEXIBLE UNDERWATER STEMS; FLOWERS STICKING OUT OF WATER are most abundant in brownish, shallow, fresh water over bottoms mushy with decaying vegetation. The stems grow horizontally or slantwise; vary from an inch long in Dwarf Bladderwort to twenty feet in Giant Bladderwort; and are usually branched. The leaves collapse when taken out of water. Some kinds are hard to tell apart when they don't have flowers. When in bloom, their yellow, purplish, or whitish flowers are on out-of-water stalks.

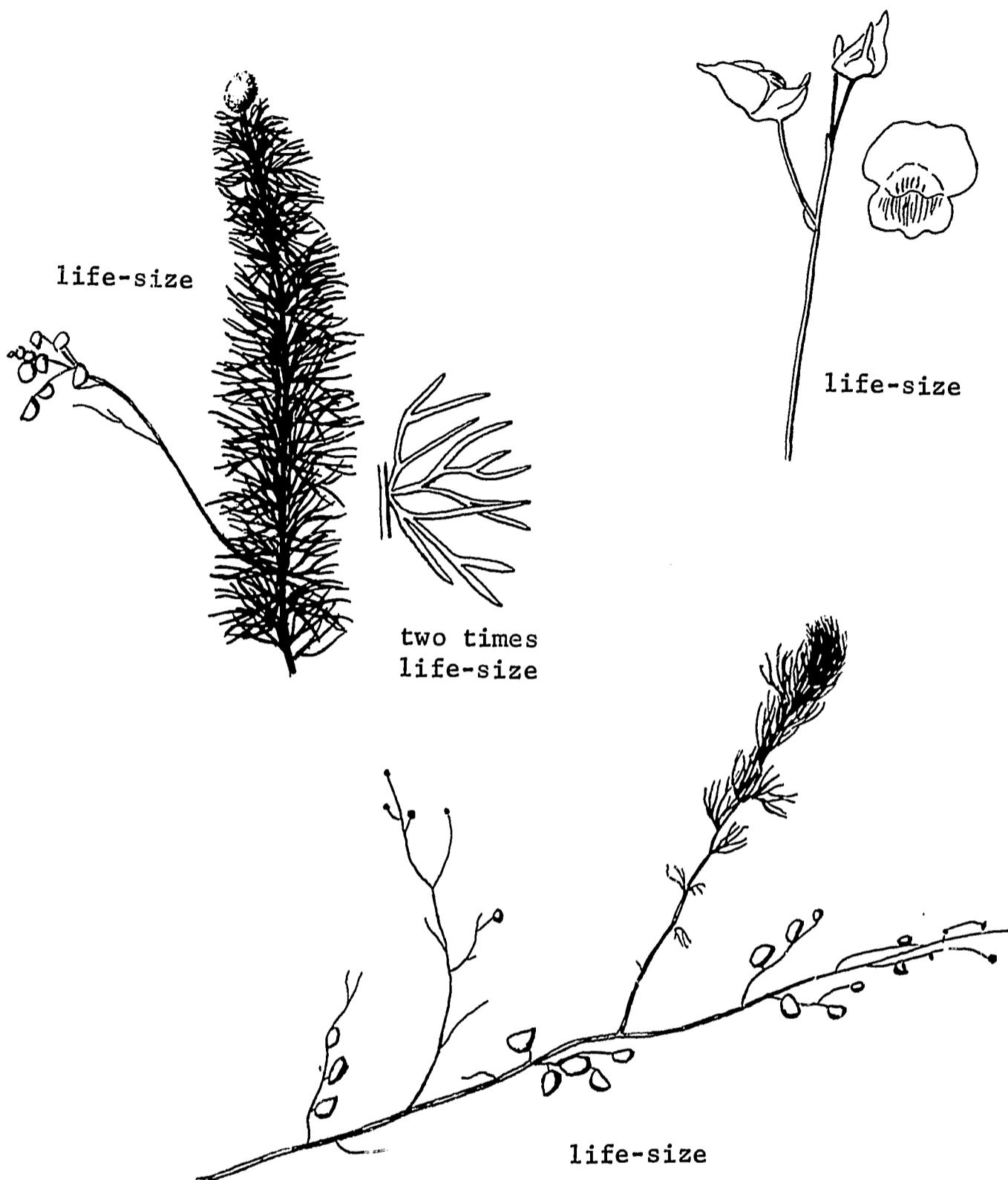
Bladderworts which do not have forked underwater leaves are described on pages 26 and 27.

NORTHERN BLADDERWORT,
Utricularia minor

Fresh water; Alaska to Greenland, California, Colorado, and Pennsylvania.

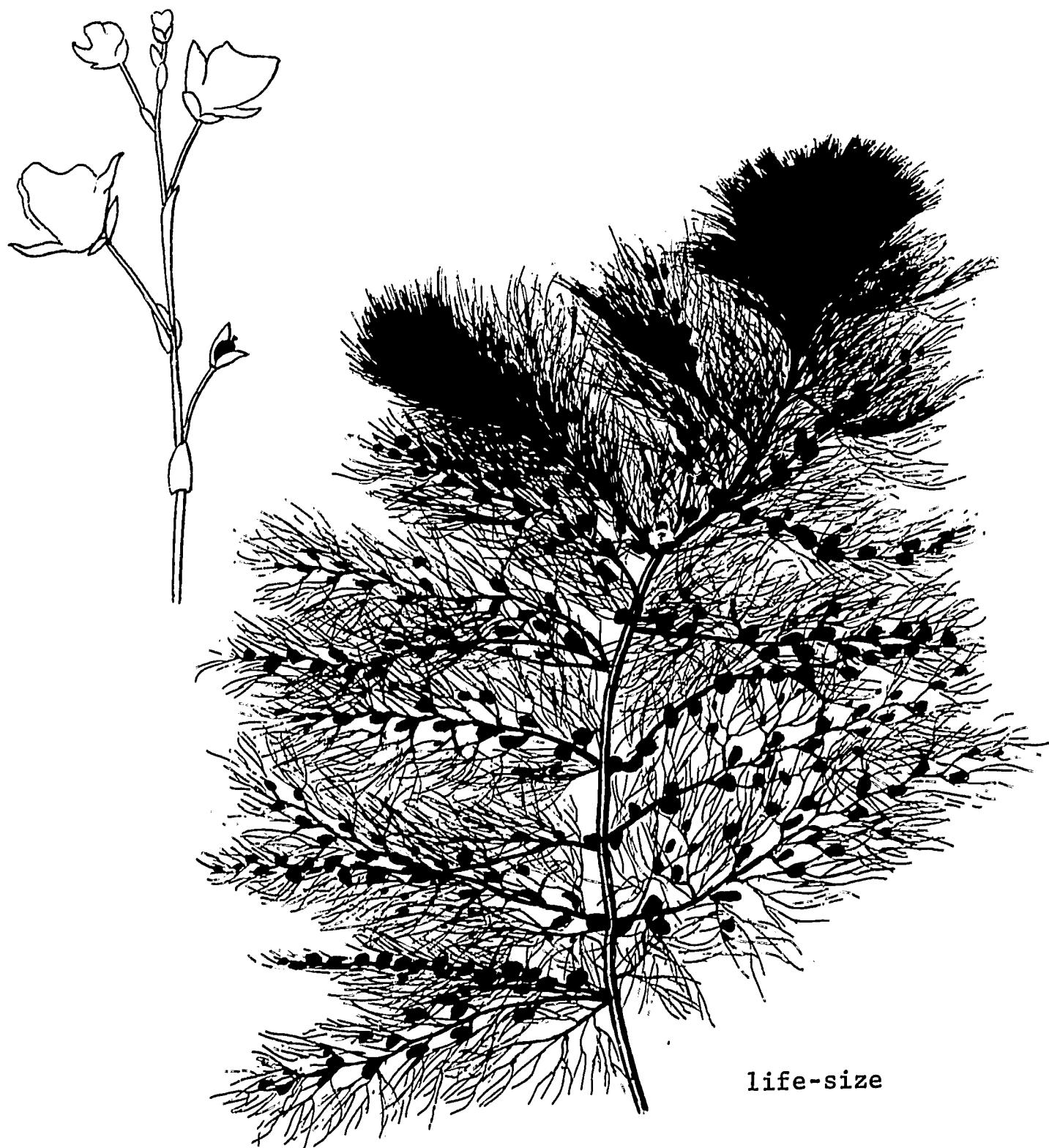
Bladders and green leaves are mixed together. The leaves fork into flattish, very-sharp-tipped leaflets. Flowers are yellow.





FLATLEAF BLADDERWORT, *Utricularia intermedia*
(*Utricularia ochroleuca*)

Fresh water; Alaska to Greenland, California, and New Jersey.
Has two kinds of branches. One is thickly covered with green leaves which fork into flattish, usually blunt-tipped leaflets. The other has scattered, colorless to blackish bladders. Flowers are yellow.



COMMON BLADDERWORT, *Utricularia vulgaris*
(*Utricularia macrorhiza*)

Fresh water; Alaska to Newfoundland, California, Arkansas, and North Carolina.

Flowers are yellow.

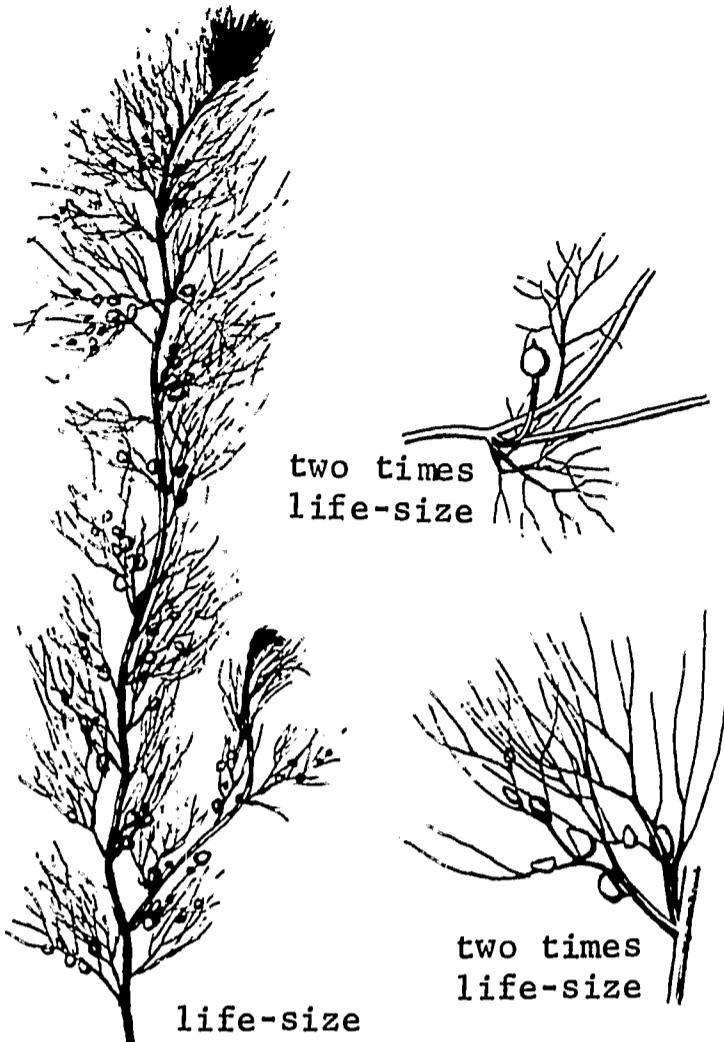
Foliage resembles that of Hidden-flower (page 46), Little Floating (page 48), and Big Floating (page 49) Bladderworts. The leaves are usually much larger and more forked than those of Hidden-flower, and they have larger bladders. The leaves have less zigzag forking and larger bladders than Little Floating. The leaves have less zigzag forking than Big Floating.

HIDDEN-FLOWER BLADDERWORT,
Utricularia geminiscapa

Fresh water; Wisconsin to Newfoundland and Virginia.

Here and there along a main stem are globular pods about the size of a bladder, on a stalk no more than 1/2 inch long. These develop from petal-less flowers.

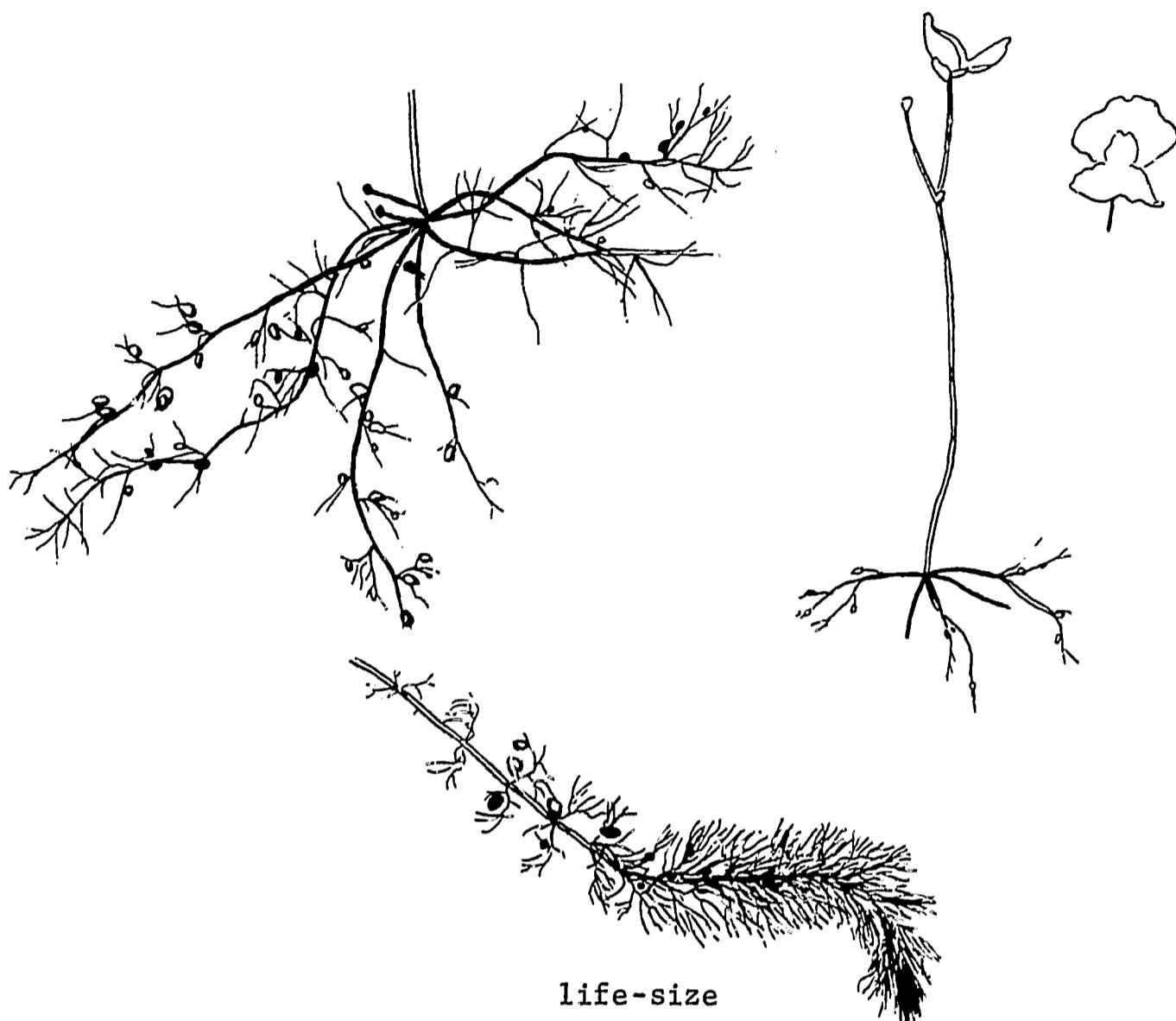
Resembles small plants of Common Bladderwort (page 45); but Hidden-flower's leaves are usually less-forked, its bladders are usually smaller, and its petal-bearing flowers are much smaller.



PURPLE BLADDERWORT,
Utricularia purpurea
(*Vesiculina purpurea*)

Fresh water; Wisconsin to Nova Scotia, Texas, and Florida (but not in the Middle Mississippi Valley).

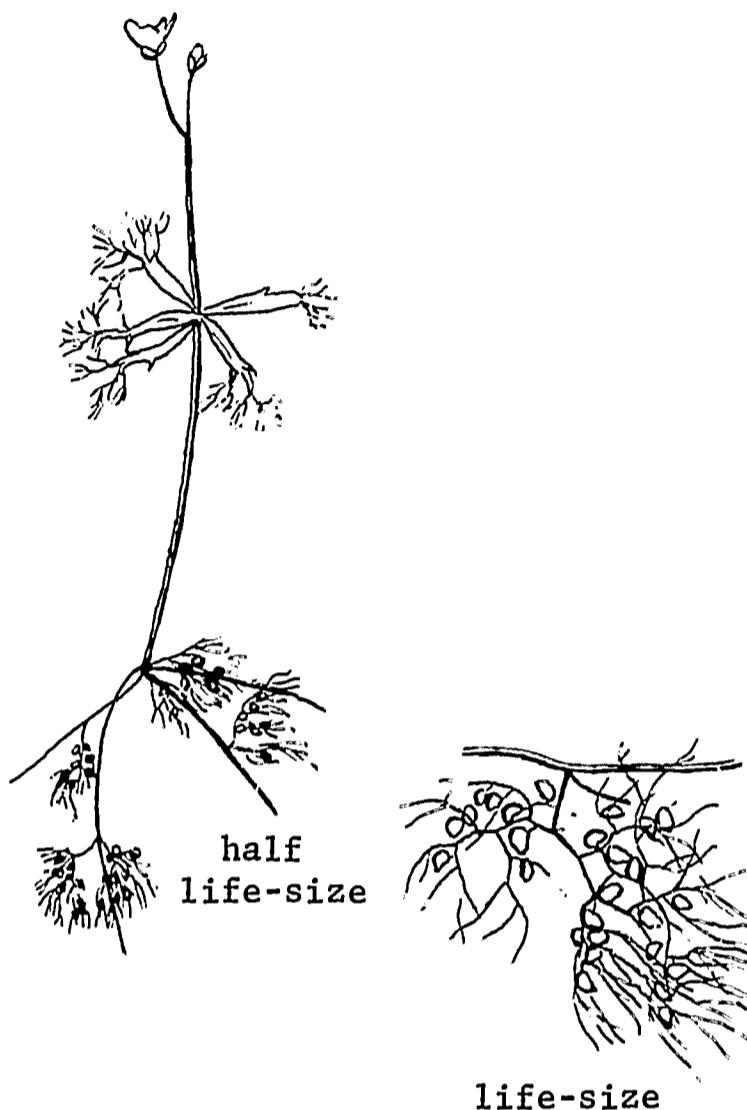
The only Bladderwort with a cluster of branches at each joint of its stems. Flowers are purplish.



EASTERN BLADDERWORT, *Utricularia gibba*
(*Utricularia biflora*, *fibrosa*, and *pumila*)

Fresh water; California; and Minnesota to Nova Scotia,
Texas, and Florida.

Foliage is dense or sparse; is mixed with bladders,
or foliage and bladders are on separate branches. Flowers
are yellow.



LITTLE FLOATING BLADDERWORT, *Utricularia radiata*
(Utricularia inflata var. minor)

Fresh water; Indiana to Nova Scotia, Texas, and Florida.

Most of the plant is under water; but its flowers stand above a whorl of swollen, oblong, floating leaves which have fine-forked ends. Flowers are yellow.

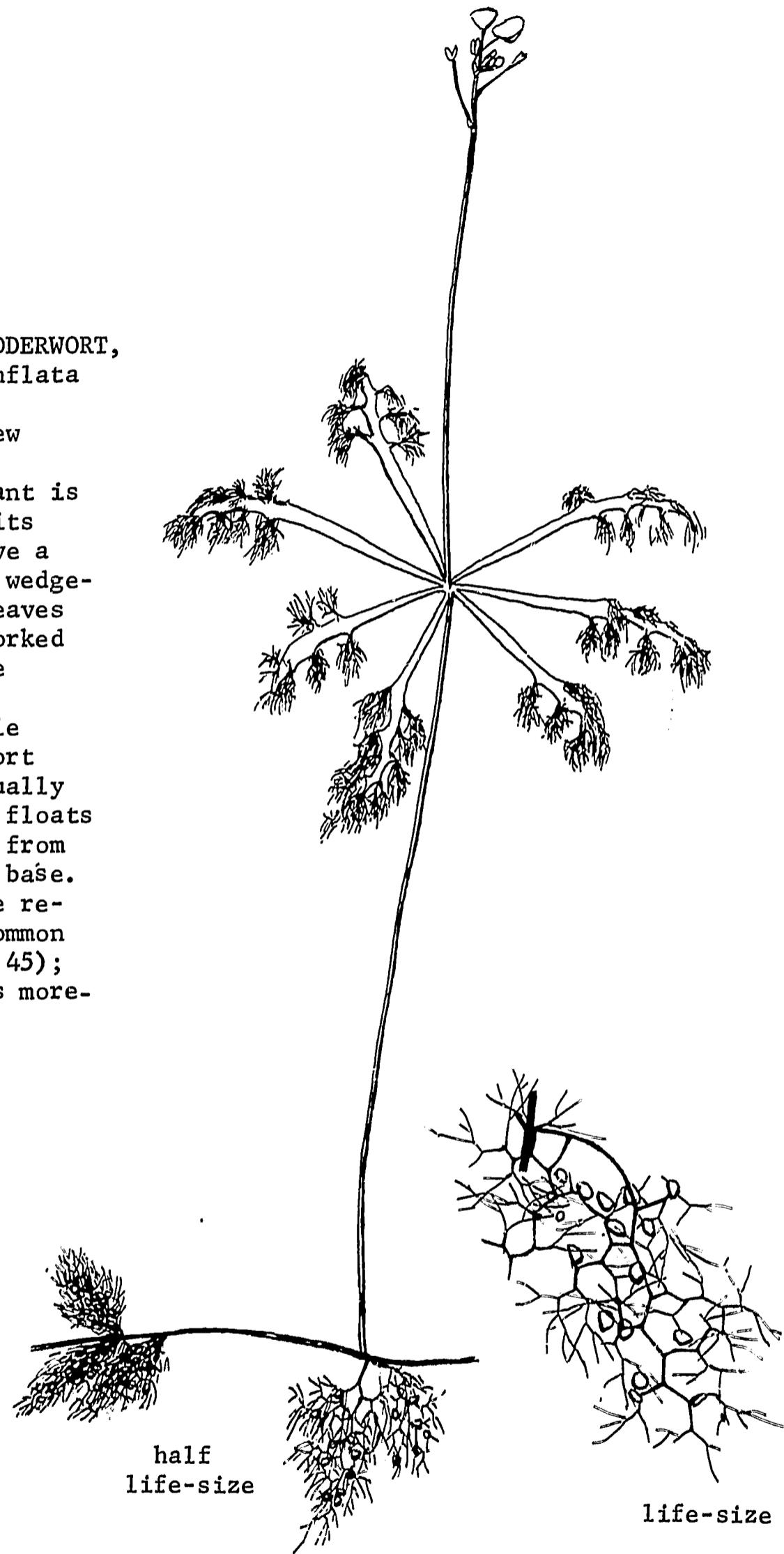
Resembles Big Floating Bladderwort (page 49); but usually is smaller, and its floats have nearly parallel sides which pinch in near their base. Underwater foliage resembles that of Common Bladderwort (page 45); but it usually has more-zigzag forking and smaller bladders.

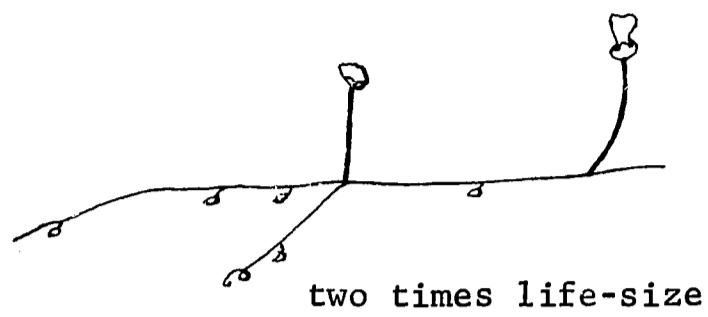
BIG FLOATING BLADDERWORT,
Utricularia inflata

Fresh water; New Jersey to Texas.

Most of the plant is under water, but its flowers stand above a whorl of swollen, wedge-shaped floating leaves which have fine-forked ends. Flowers are yellow.

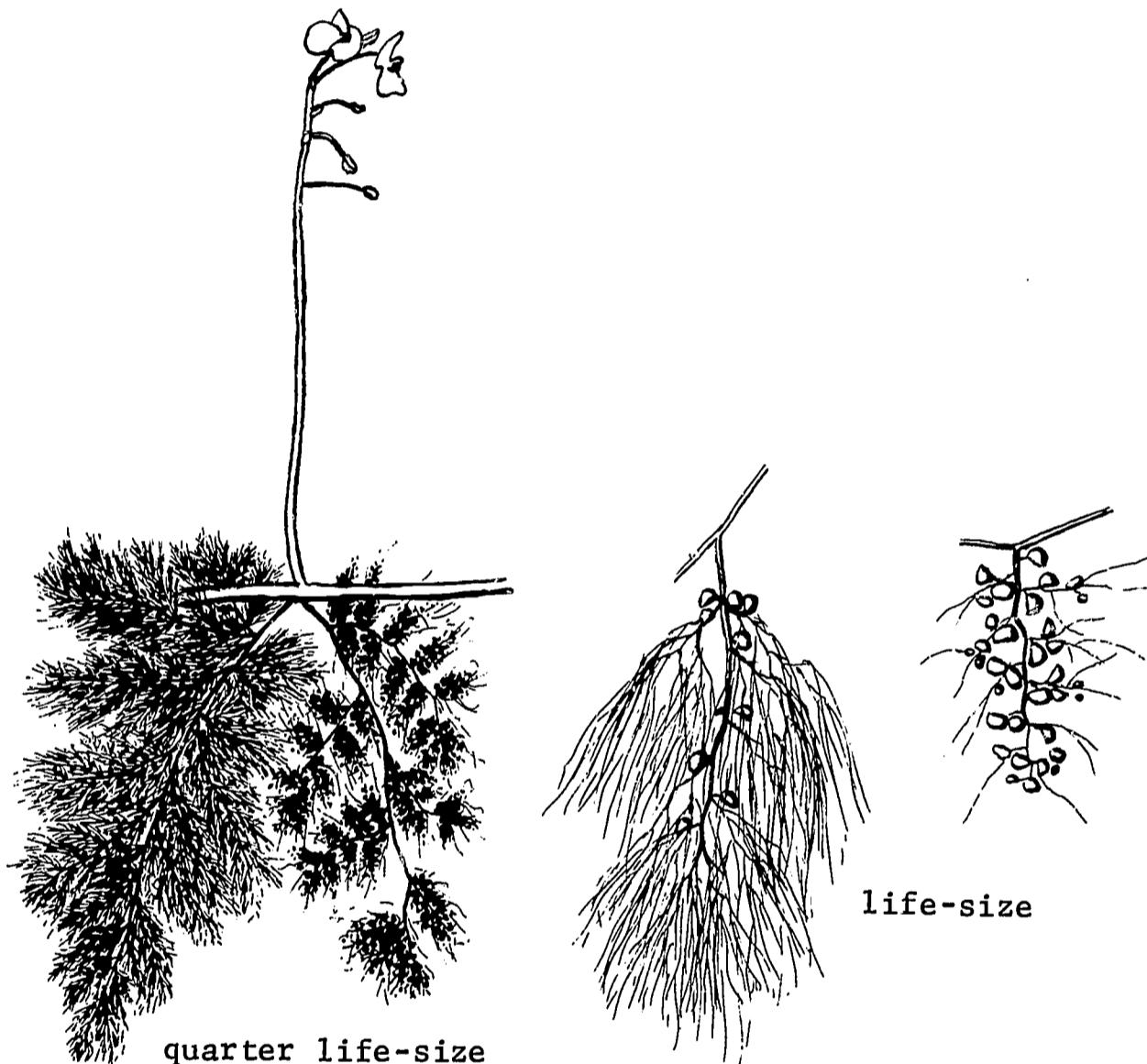
Resembles Little Floating Bladderwort (page 48); but usually is larger, and its floats taper all the way from the middle to the base. Underwater foliage resembles that of Common Bladderwort (page 45); but it usually has more-zigzag forking.





DWARF BLADDERWORT,
Utricularia olivacea
(*Biovularia olivacea*)

A tiny plant with whitish flowers which has been found at one locality each in New Jersey, North Carolina, South Carolina, Georgia, and Florida.

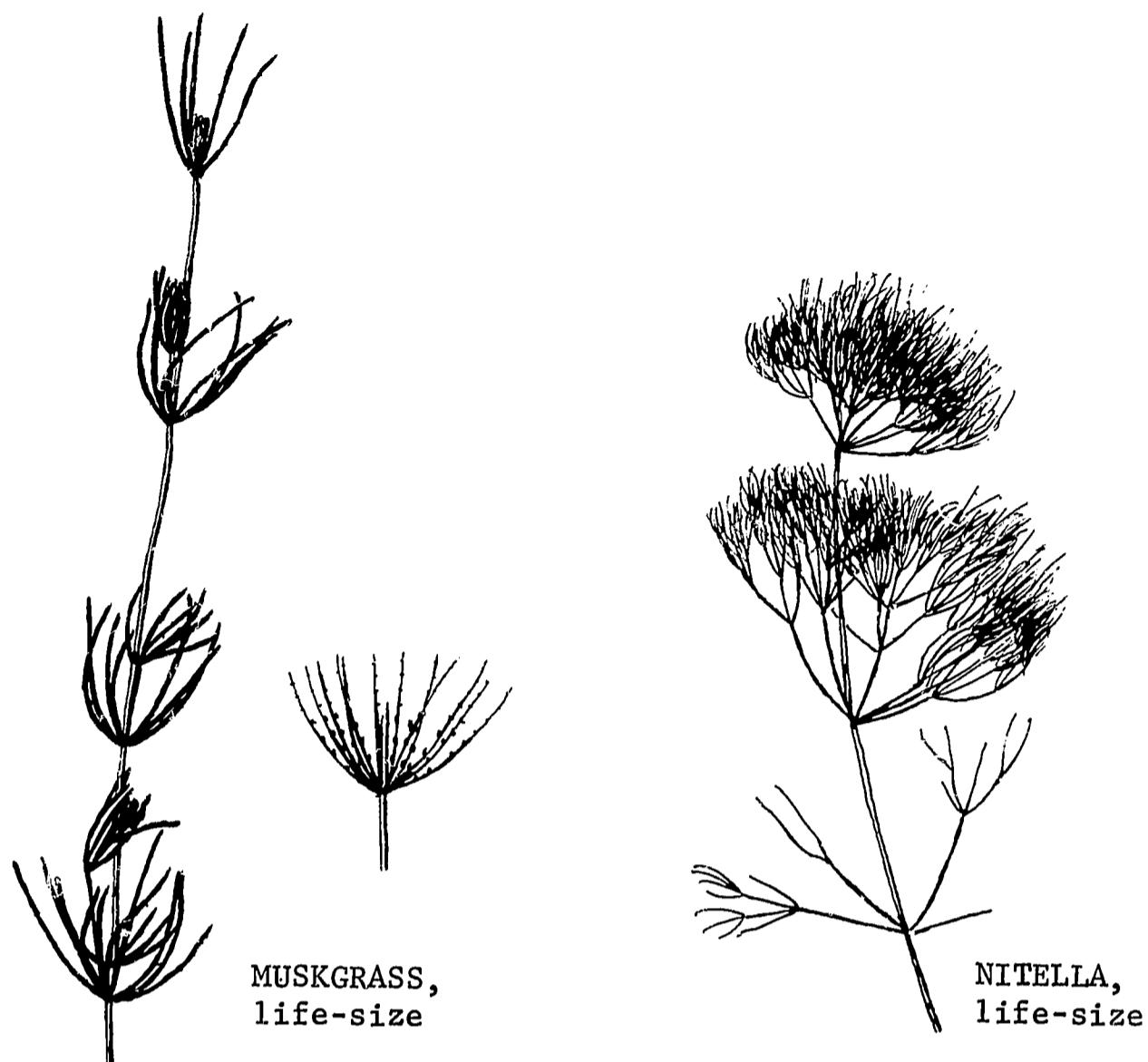


GIANT BLADDERWORT, *Utricularia foliosa*
(*Utricularia floridana*)

Fresh water; Louisiana to Georgia and Florida.

From a few feet to twenty feet long. Has flattish stems with two kinds of branches. One kind is a mass of threadlike green leaflets with a few interspersed bladders. The other is a mass of colorless to blackish bladders with a few interspersed leaflets. Flowers are yellow.

Group 5. PLANTS WITH CLUSTERED BRANCHES OR FINE-FORKED,
BLADDERLESS, USUALLY LIMP LEAVES ON FLEXIBLE UNDERWATER STEMS; STEM
TIPS SOMETIMES STICKING OUT OF WATER grow in fresh inland water and
in fresh to brackish coastal water. The stems vary from upright to
horizontal and from a few inches long to several feet; and they are
usually branched. The underwater leaves usually collapse when taken
out of water. Some kinds produce small floating or out-of-water
leaves and have white, yellow, or purplish flowers at the surface
of the water or a little above it.



MUSKGRASSES, *Chara*; NITELLAS, *Nitella*; TOLYPELLAS, *Tolypella*

Fresh to brackish water, inland and coastal; Alaska to Greenland, California, and Florida.

Identifying these algae, which mingle with flowering plants and resemble some of them, requires a microscope and Richard D. Wood and Kozo Imahori's "A Revision of the Characeae" (1964-65). These two volumes include pictures and descriptions of all of the kinds of Characeae known from Canada and the United States: eight Muskgrasses, twelve Nitellas, and two Tolypellas.

The different kinds vary from larger than those pictured here to much smaller, and from more branched to less branched.

Muskgrasses usually have short, even-length branches clustered at each joint; and these usually have clusters of much-shorter branchlets. Usually the plants have a skunky odor; often they are coated with lime; and sometimes they are prickly-looking.

Nitellas have short, even-length branches clustered at each joint; and these branches often end in bushy clusters of branchlets. The plants seldom have a skunky odor or a coating of lime.

Tolypellas (not pictured) have short branches of different lengths clustered at each joint; therefore they look ragged.

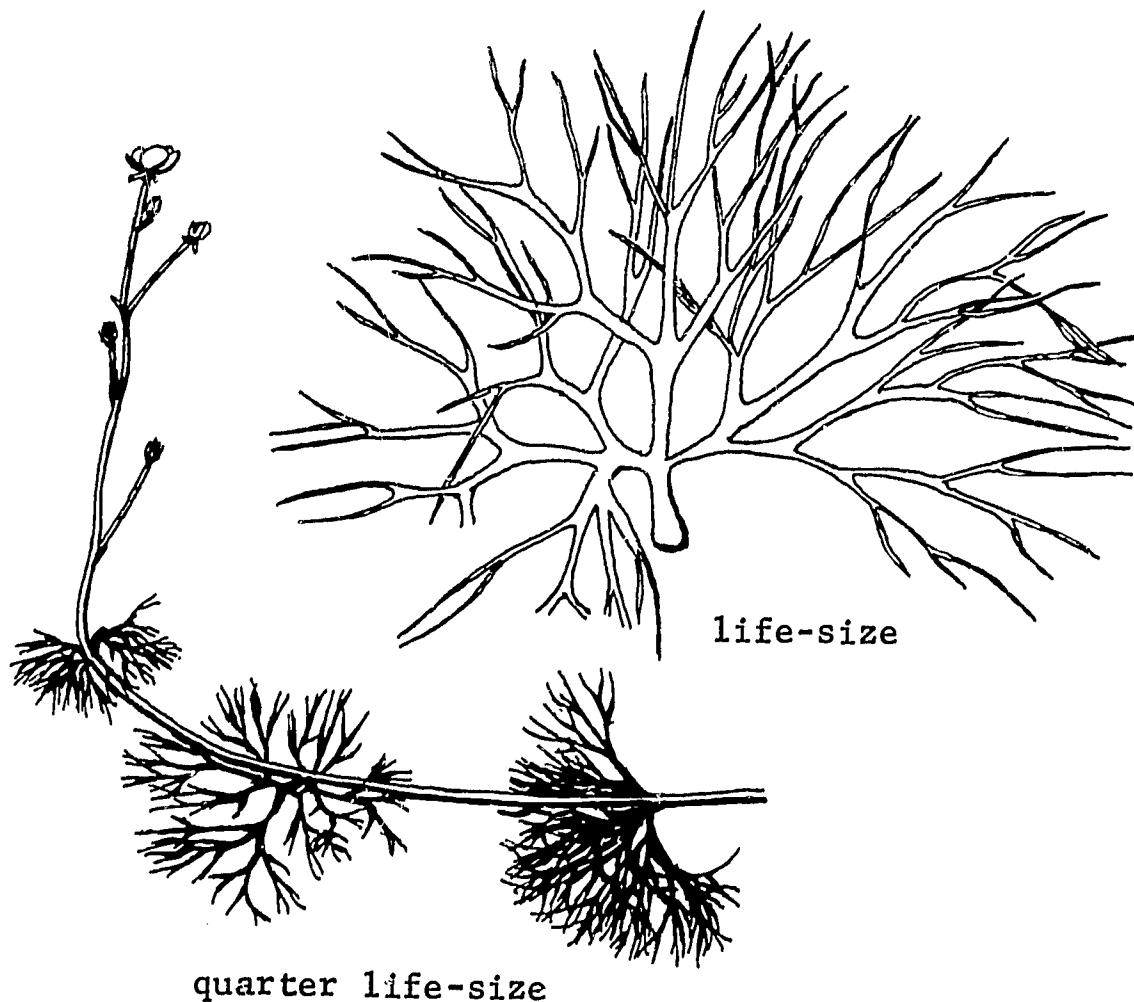


WHITE WATER BUTTERCUP, *Ranunculus aquatilis*
(Ranunculus longirostris, subrigidus, and trichophyllum;
Batrachium flaccidum and trichophyllum)

Fresh water, often in slow streams; Alaska to Greenland, California, and Alabama (but rare in the southeastern states).

Stems usually just under water. Leaves firm to limp, stalkless to long-stalked; a single stalkless leaf sometimes looking like a cluster of several leaves. Sometimes stems have a few floating leaves. In summer, 5-petaled flowers often whiten a patch of water. Their stalks soon curve back into the water and are tipped with little balls of usually a dozen or more seeds. During low water in summer, patches of stems sometimes grow on mud.

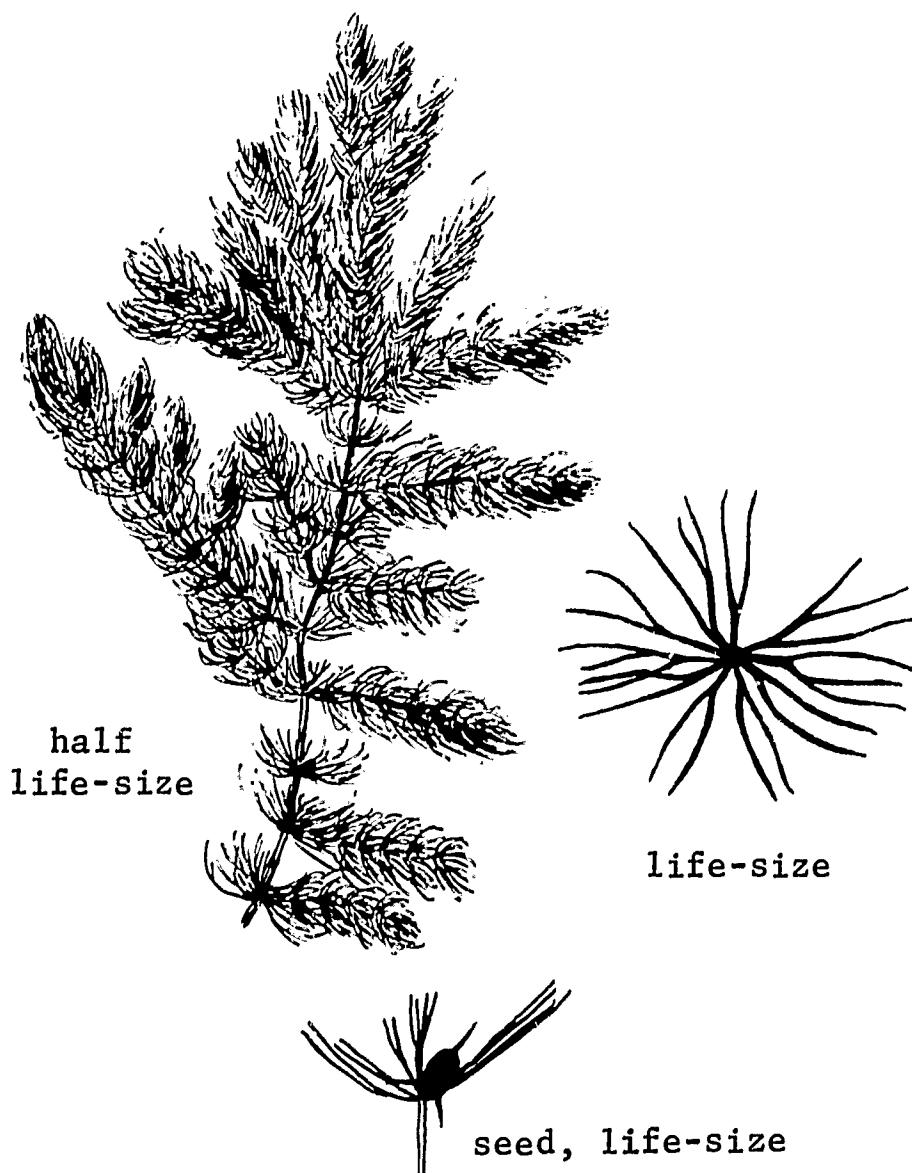
Resembles Lobb Buttercup (page 113), which has mainly floating leaves, fewer seeds in a ball, and grows only from British Columbia to California.



**YELLOW WATER BUTTERCUP, *Ranunculus flabellaris*
(*Ranunculus delphinifolius* and *gmelini*)**

Fresh water; Alaska to Newfoundland, California, Louisiana, and North Carolina (but rare in the southeastern states).

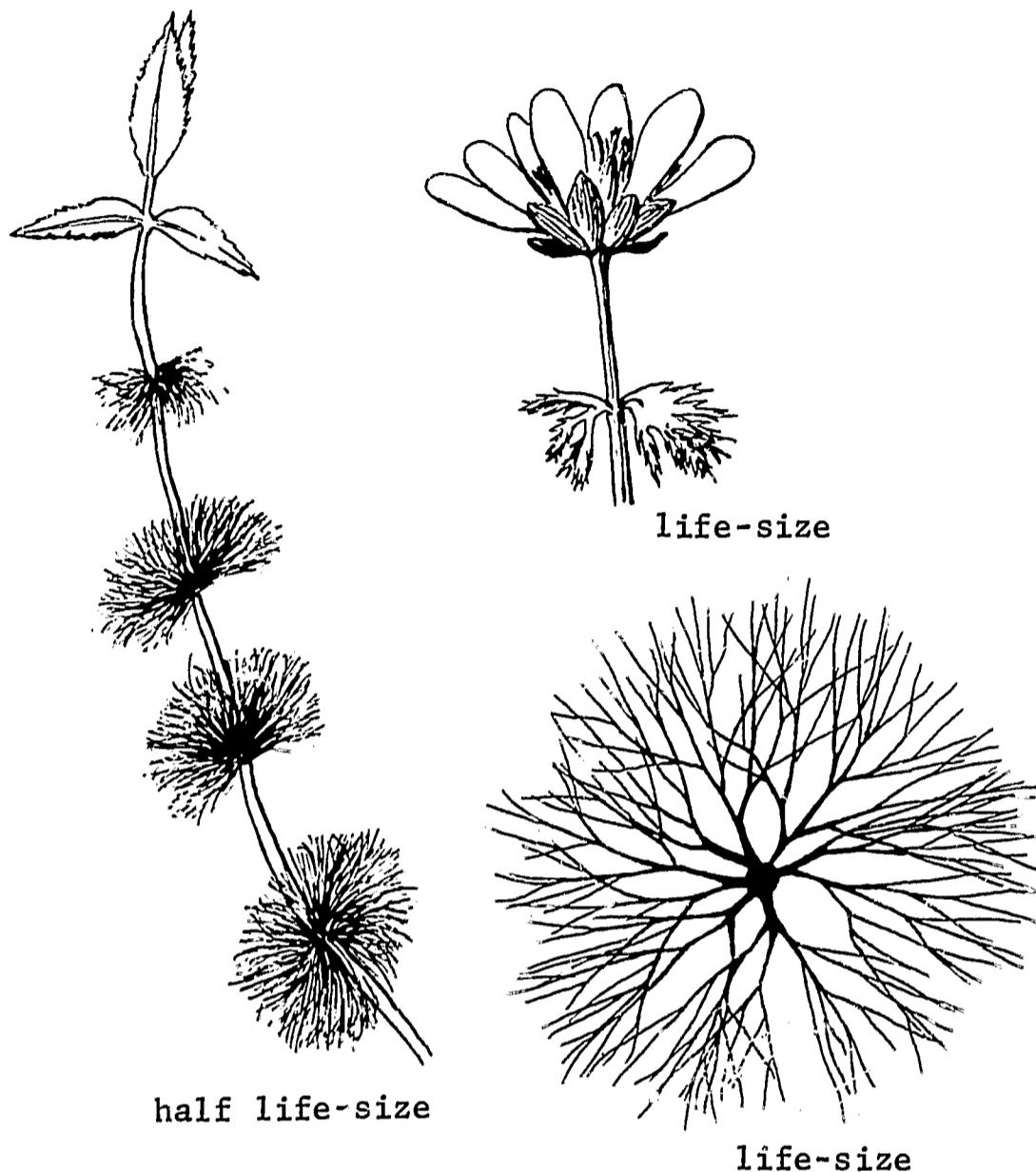
Stems usually just under water. Sometimes stems have firmer, less-divided floating leaves or out-of-water leaves. In late spring and summer, loose clusters of 5-petaled yellow flowers stand a little above water.



COONTAIL, *Ceratophyllum demersum*
(*Ceratophyllum echinatum* and *submersum*)

Fresh water, inland and coastal; Northwest Territories to Nova Scotia, California, and Florida.

Stems entirely under water; usually much-branched, and sometimes stiff with a coating of lime. At each joint is a whorl of leaves. Leaflets vary in length, width, firmness, amount of forking, and prominence of teeth. Flowers and seeds, at base of leaves, are usually hard to find. The commonest form of seed is pictured. Other forms have as many as a dozen spines.



**WATER-MARIGOLD, *Bidens beckii*
(*Megalodonta beckii*)**

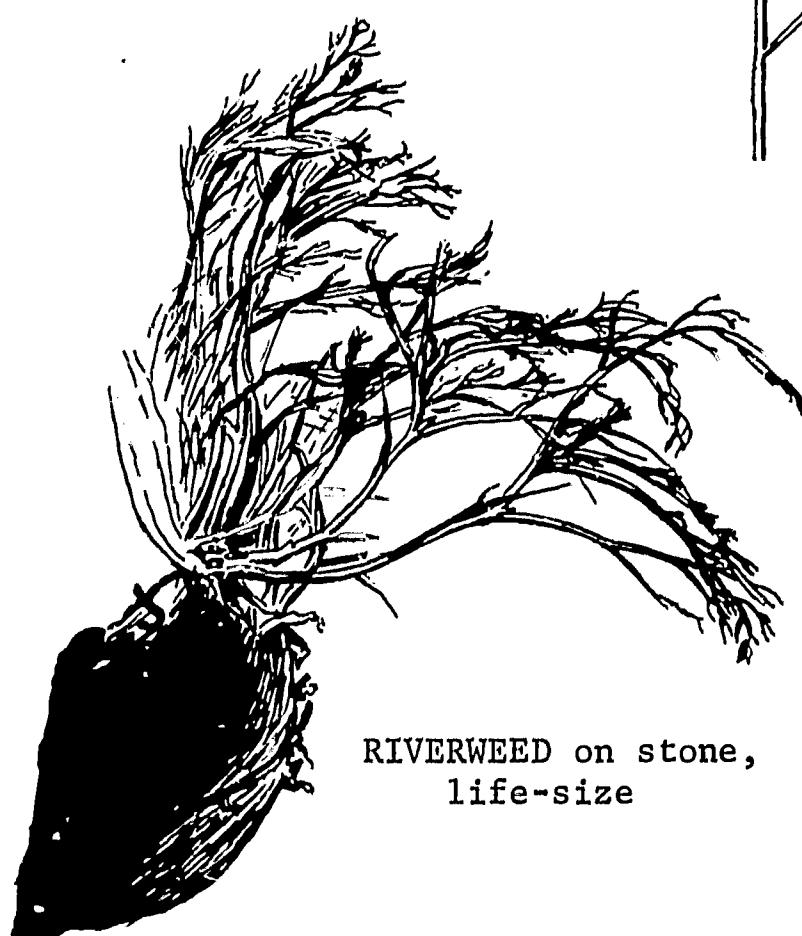
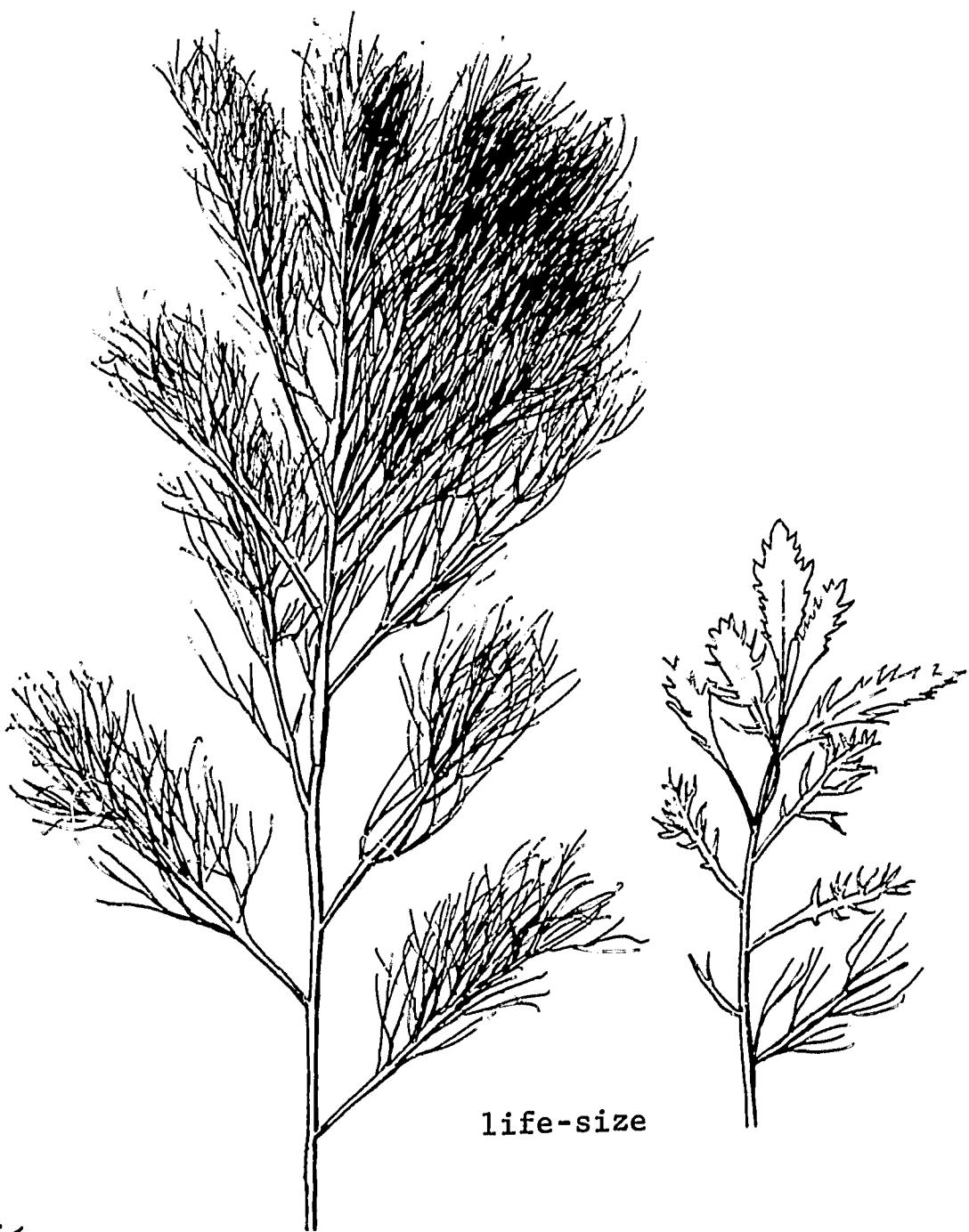
Fresh water; Washington and Oregon; and Saskatchewan to Nova Scotia, Missouri, and New Jersey.

The stalkless leaves, in pairs at each joint, look like a cluster of several leaves. Stem tips with two or three pairs of less-divided or merely toothed leaves and a yellow flower head reach a little out of water.

LAKE CRESS,
Armoracia aquatica
(*Neobeckia aquatica*)

Fresh water;
Minnesota to Quebec,
Louisiana, and Florida
(but rare south
of Missouri and New
York).

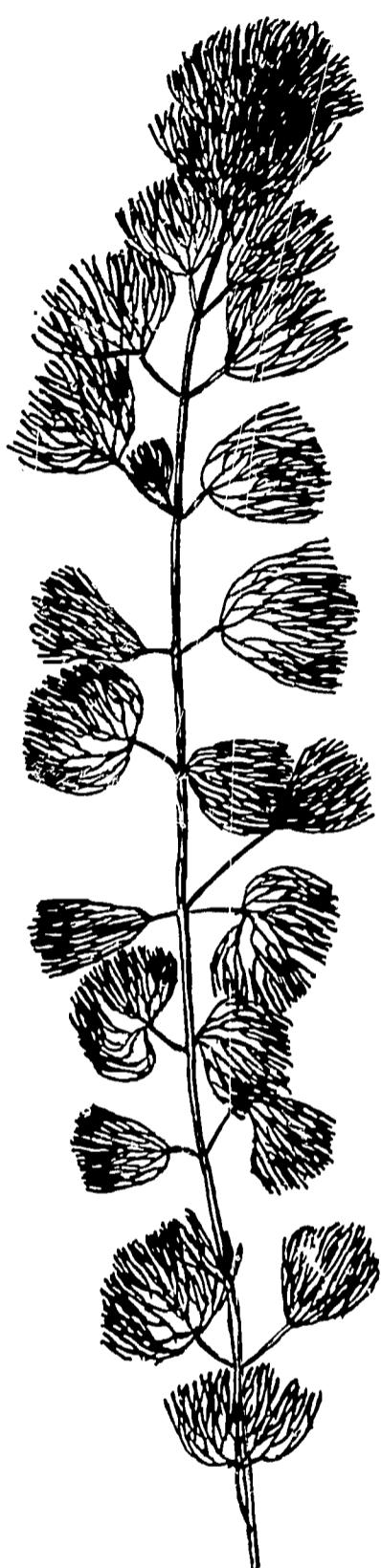
Stems which grow
under water have
fine-forked leaves,
the leaflets of
which are uneven-
ended. Stems or
stem tips which grow
out of water have
leaves which vary
from fine-forked to
undivided. Some-
times these out-of-
water stems have
loose clusters of
white flowers.



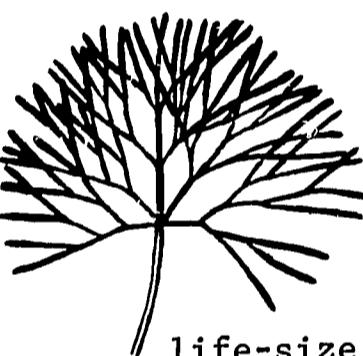
RIVERWEED,
Podostemum ceratophyllum
(*Podostemon abrotanoides*
and *ceratophyllum*)

Stony-bottom streams,
Quebec to New Brunswick,
Texas, and Georgia.

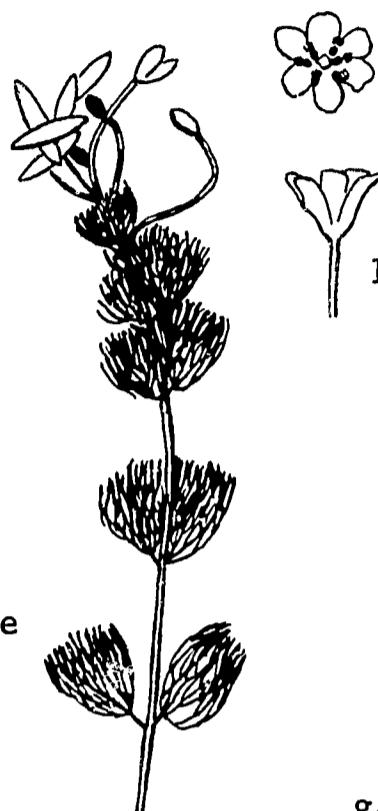
Tough stems grow in a
dull-green tangle. Their
bases cling to stones
instead of rooting among
them.



half
life-size



life-size

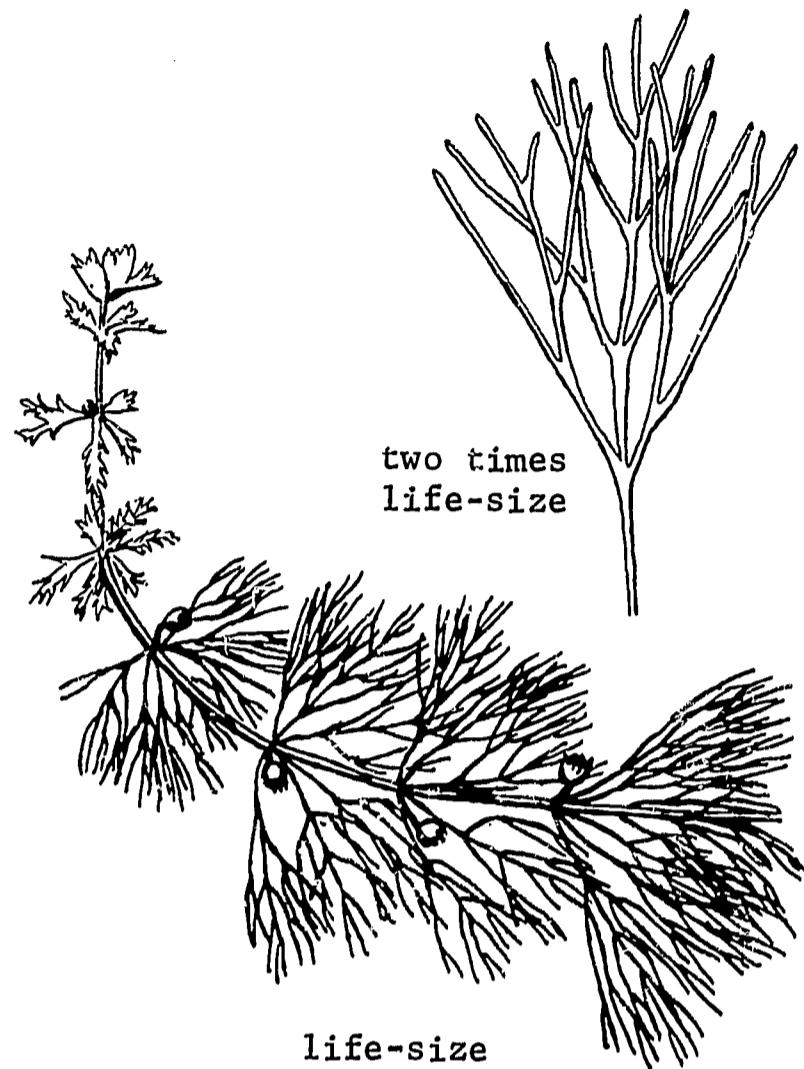
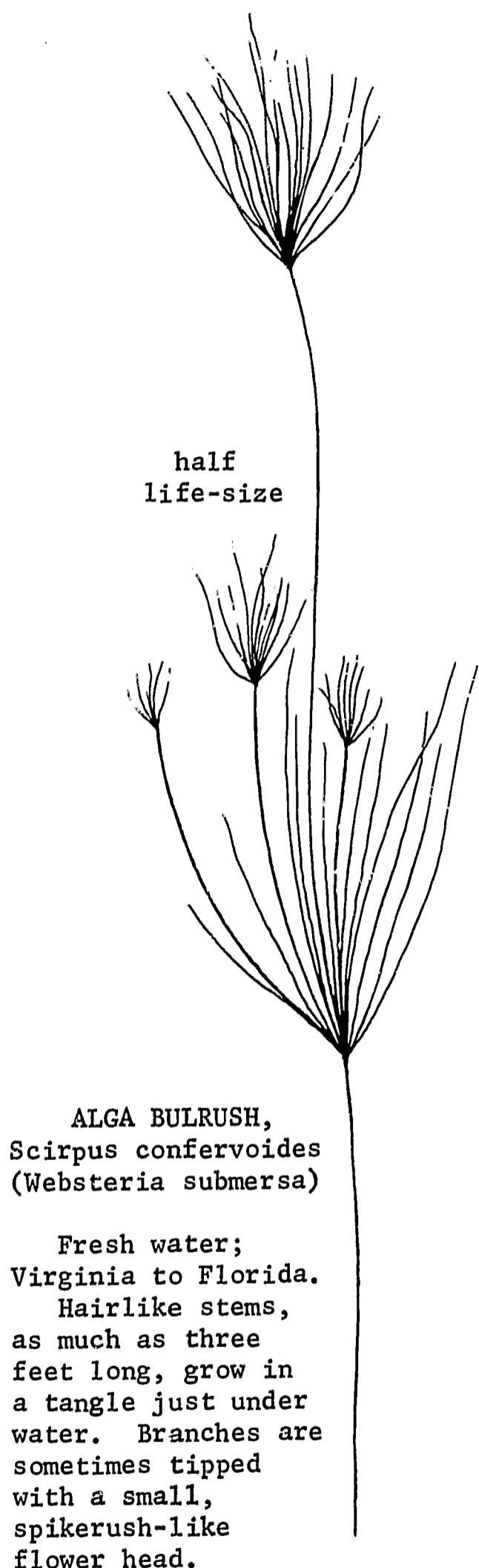


life-size

FANWORT,
Cabomba caroliniana

Fresh water; Michigan to New Hampshire, Texas, and Florida.

Leaves are on short or long stalks which are in pairs at each joint. Unlike most other underwater plants, the forked leaflets are a little wider at the tip than the base. Six-parted white or lavender flowers and small, narrow floating leaves are at the tip of stems which reach the surface of the water.

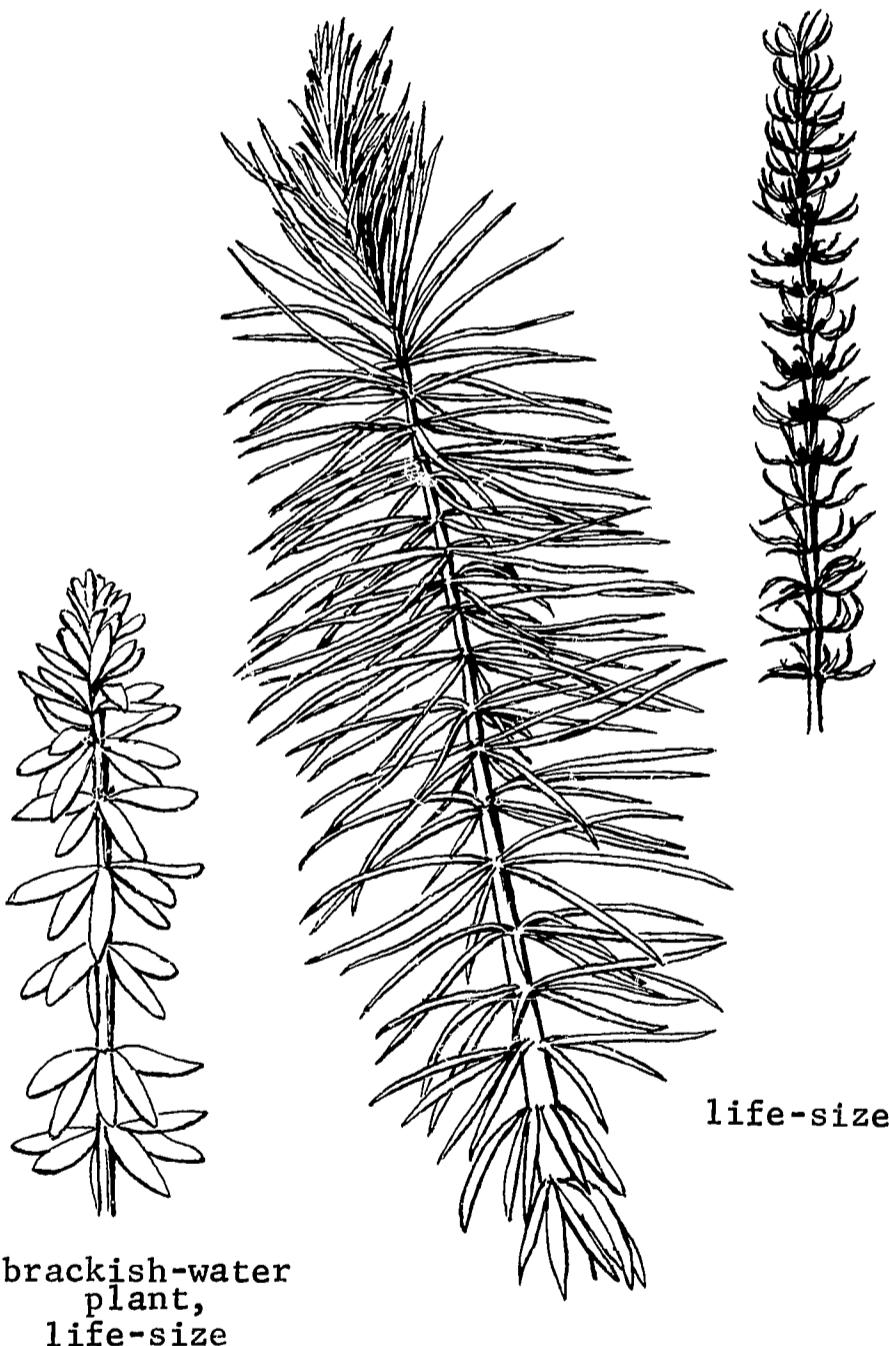


LIMNOPHILAS, *Limnophila*

Limnophila indica and *Limnophila sessiliflora*, natives of southeastern Asia, are grown in North America as aquarium plants and have run wild in fresh water in Texas, Louisiana, and Florida.

Out-of-water foliage looks a little like that of Variable Watermilfoil (page 35); but among the leaves are purplish flowers which produce stalkless or short-stalked pods filled with tiny seeds. Underwater foliage looks a little like that of Fanwort (page 58); but the leaves are in clusters instead of twos; and the leaflets are not wider at the tip than the base.

Group 6. PLANTS WITH NEEDLELIKE TO OVAL PAIRED OR BUNCHED LEAVES ON MAINLY FLEXIBLE UNDERWATER STEMS; SOME KINDS SOMETIMES OUT OF WATER
grow in fresh inland water and in fresh to brackish coastal water.
The stems vary from upright to horizontal and from an inch high to
several feet long; and they are usually branched. The leaves of some
kinds are limp and collapse when taken out of water; those of others
are stiff. Plants grow all the way to shore from depths of several
feet. Several species are hard to tell apart without seeds; but seeds
are usually common in summer.

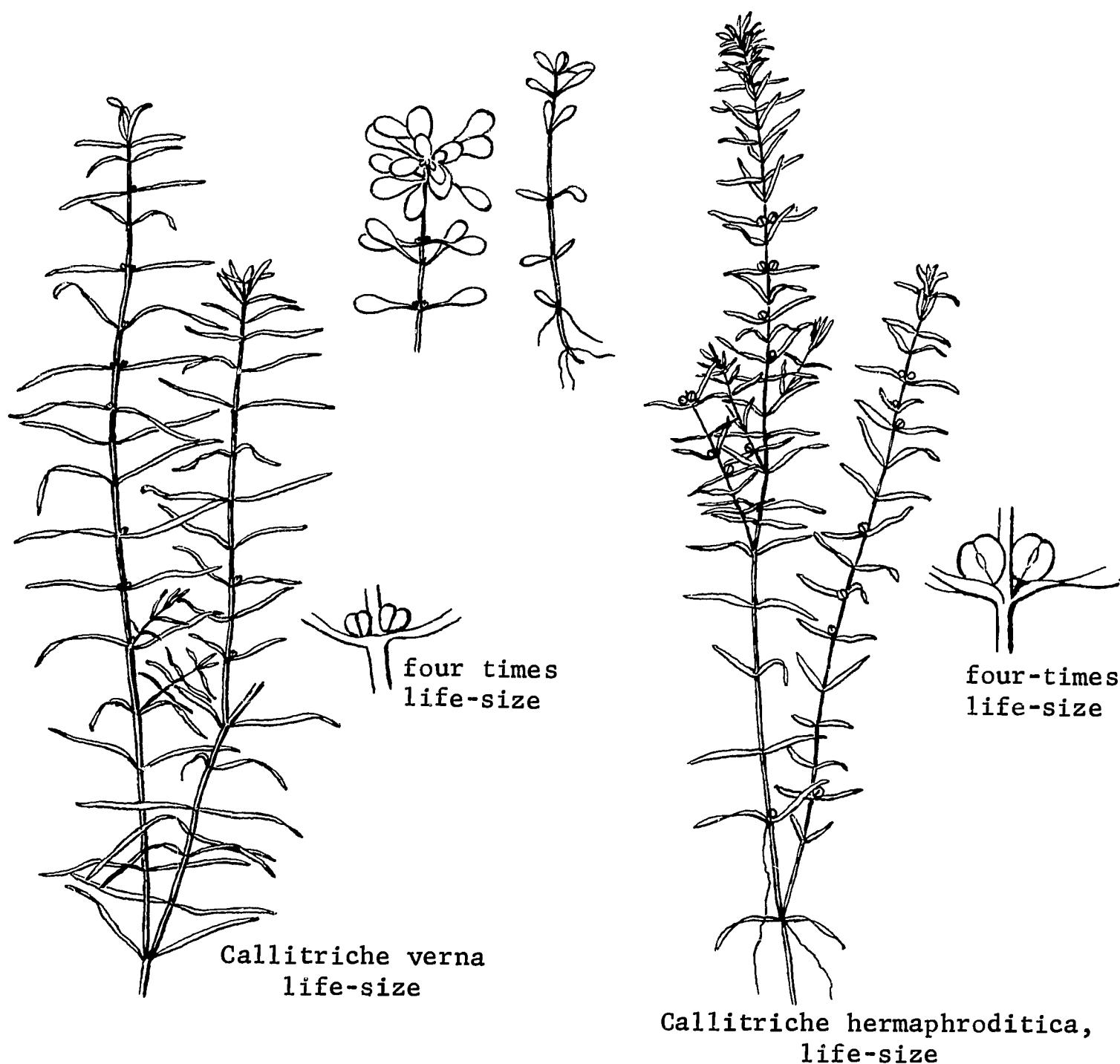


MARESTAIL,
Hippuris vulgaris
(*Hippuris tetraphylla*)

Fresh inland water
and brackish coastal
water; Alaska to Green-
land, California, New
Mexico, Iowa, and New
York.

Usually upright and
at least partly out of
water. Flowers and
seeds are at base of
leaves.

life-size



WATER-STARWORTS, *Callitricha*

Fresh water, inland and rarely coastal, often in partly-shaded streams; Alaska to Greenland, California, and Florida.

Four kinds resemble each other so much that they can be told apart only by looking at them with a hand lens or microscope when they have seeds. These are partly-joined to each other in fours at the base of leaves. Under water, each of these plants has narrow leaves. All except *Callitricha hermaphroditica* also often reach the surface and

there produce a cluster of oval floating leaves; and during low water they grow on mud and have oblong leaves.

Under water, when without flowers or seeds, Water-starworts resemble slim plants of Common Elodea (page 66); but the leaves are bunched only a little toward the tip of stems, and there are only two leaves at a joint.

The four kinds are:

Callitricha hermaphroditica (*Callitricha autumnalis*). Alaska to Newfoundland, California, Colorado, and New York. Has only narrow, underwater leaves which are shorter than the underwater leaves of the other Water-starworts. Seeds are more than 1/16 inch long.

Callitricha longipedunculata. Not pictured. California. Seeds are less than 1/16 inch long and are on a stalk which is usually longer than the seeds.

Callitricha stagnalis. Not pictured. A native of Europe which has run wild from British Columbia to Oregon; and Wisconsin to Quebec and Maryland. Usually has some oval leaves. Seeds are more than 1/16 inch long.

Callitricha verna (*Callitricha anceps*, *heterophylla*, and *palustris*). Alaska to Greenland, California, and Florida. Seeds are less than 1/16 inch long and have little or no stalk.



TILLAEA, *Tillaea aquatica*
(*Tillaeastrum aquaticum*)

Fresh inland water;
Alaska to Northwest Territories, California, and Louisiana. And fresh to slightly brackish coastal water; Quebec to Newfoundland and Maryland; and Alabama.

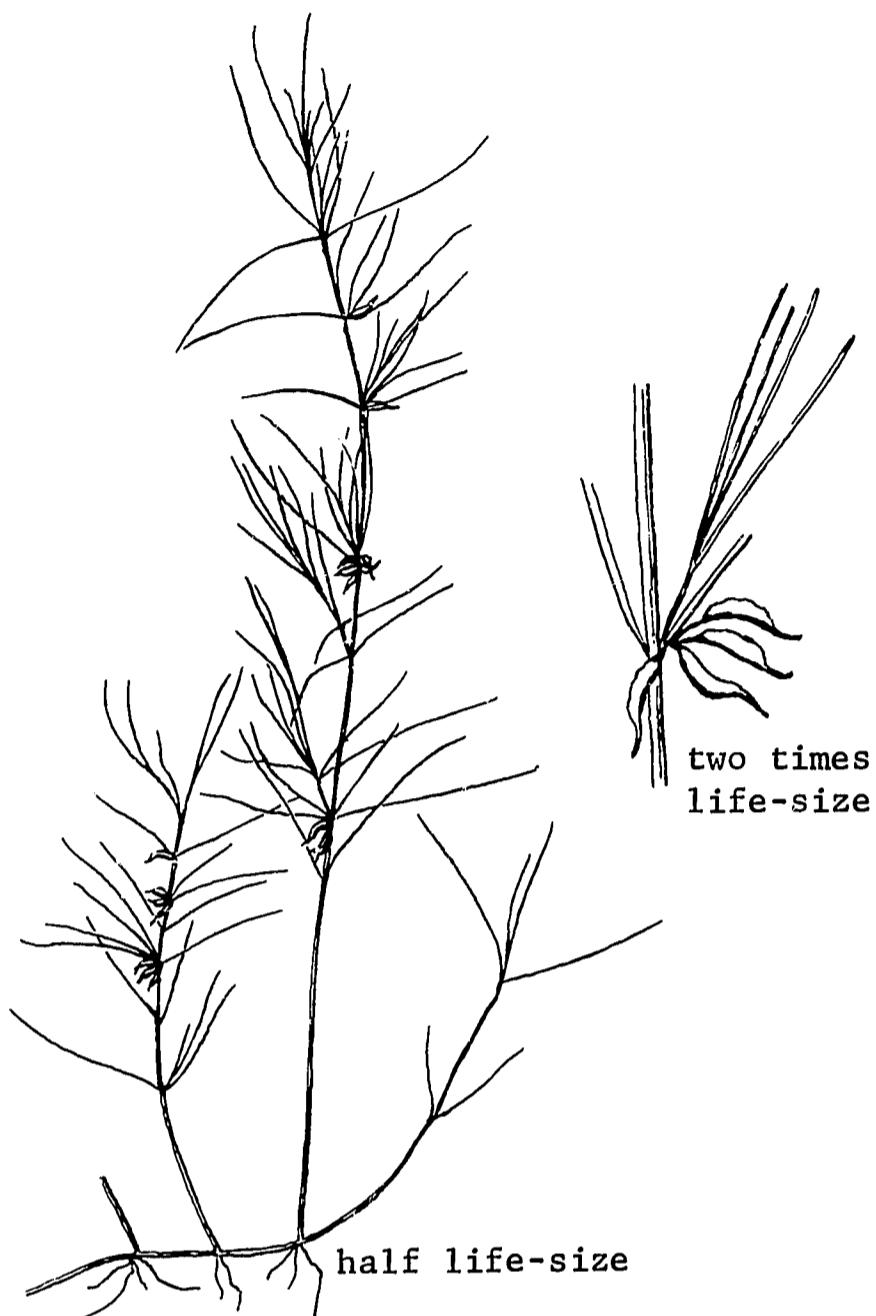
Under water or partly out of water; often under water at high tide. Tiny greenish-white flowers are on very short stalks at base of leaves.

HORNED-PONDWEED
Zannichellia palustris

Fresh and alkali inland water and fresh and brackish coastal water; Alaska to Newfoundland, California, and Florida.

From spring to fall a person can usually find the seeds, which are unlike those of any other plant.

Without seeds, Horned-pondweed resembles Slen-der (page 75), Leafy (page 77), Snailseed (page 78), and Vasey (page 80) Pondweeds; but it has leaves in pairs at all the joints of a stem.



WATERWORTS, Elatine

Fresh water, inland and coastal; Northwest Territories to Newfoundland, California, and Georgia.

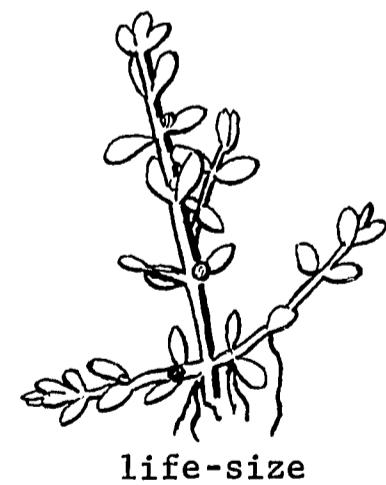
Three kinds resemble each other so much that they can be told apart only by using a microscope to look at the shape of seeds and the shape of their surface markings. The seeds are in pinhead-sized, transparent-walled pods at the base of leaves.

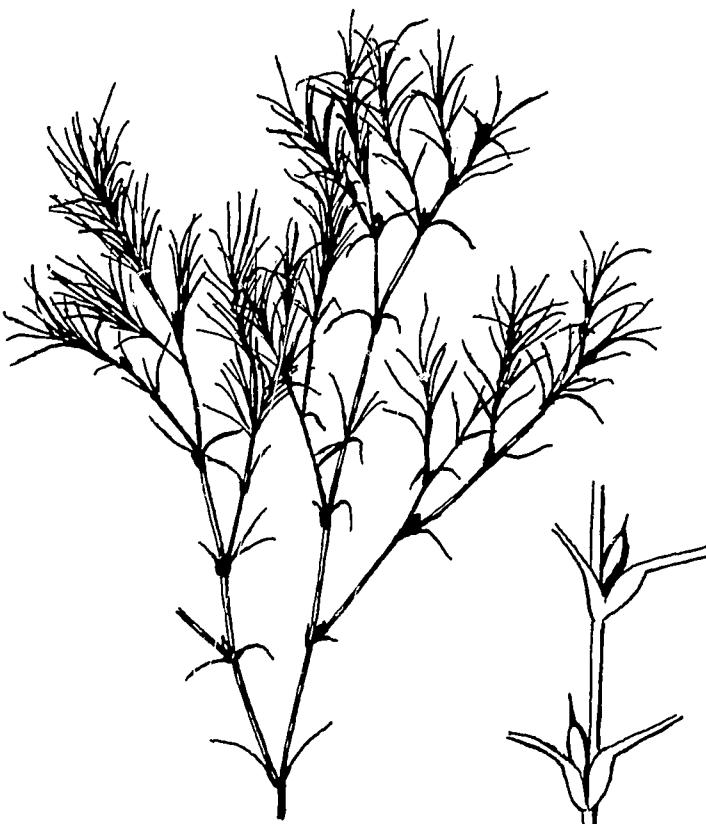
The three kinds are:

Elatine californica. Washington to Montana, California, and Arizona.

Elatine minima. Minnesota to Newfoundland and Virginia

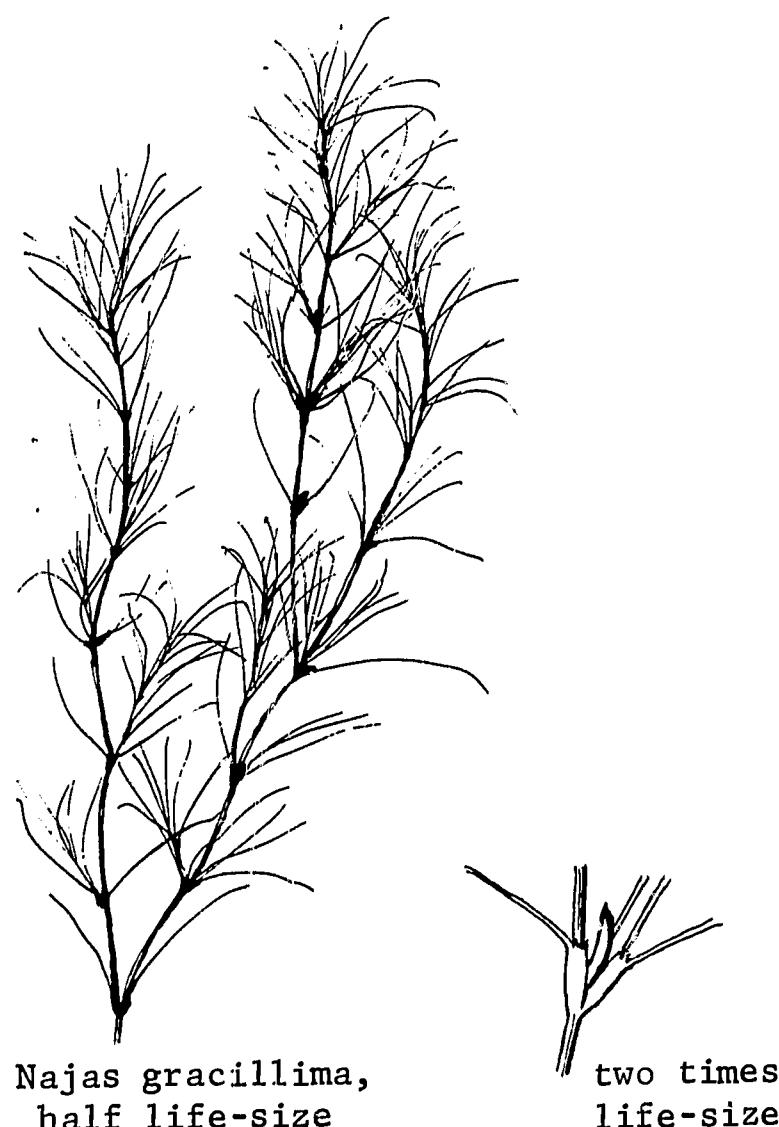
Elatine triandra (Elatine ambigua, americana, brachysperma, chilensis, gracilis, heterandra, ob-ovata, and rubella). Northwest Territories to New Brunswick, California, and Georgia.





Najas flexilis,
half life-size

two times
life-size



Najas gracillima,
half life-size

two times
life-size

NAIADS, *Najas*
(except SPINY NAIAD, page 67)

Fresh inland water and fresh to slightly brackish coastal water; British Columbia to Newfoundland, California, and Florida.

Six kinds resemble each other so much that they can be told apart only by using a hand lens or microscope to look at the toothing of leaf edges, the shape and toothing of leaf bases, and the markings on seeds. Tops of plants are often almost out of sight under water. Plants vary in size from tufts an inch high on sandy bottom to much-branched plants two or three feet high on silty bottom.

The six kinds are:

Najas conferta. Not pictured. Southwestern Georgia and western Florida. Leaves usually curve out from the stem, and their marginal teeth are visible to the naked eye. Resembles *minor* (page 65); but the seeds are not ribbed lengthwise.

Najas flexilis. British Columbia to Newfoundland, California, Missouri, and Virginia. Leaves usually curve out from the stem. Unlike the other kinds, its seeds are shiny under the dull, easily-rubbed-off skin.

Najas gracillima. Minnesota to Maine, Missouri, and North Carolina. Threadlike leaves usually curve out from the stem. Resembles *flexilis*; but usually has slenderer

leaves and has wide-topped leaf bases and dull seeds.

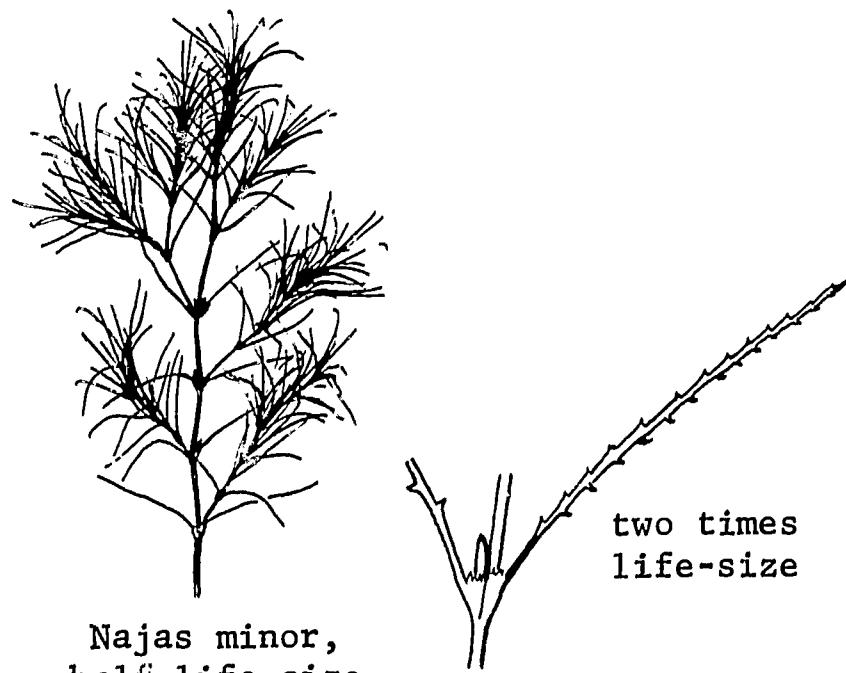
Najas graminea.
Not pictured. A native of the Old World which has run wild in California ricefields. Very bushy with leaves which usually curve out from the stem. Resembles *flexilis* (page 64); but has dull seeds.

Najas guadalupensis (*Najas muenscheri* and *olivacea*). Oregon to Quebec, California, and Florida. Leaves are shorter than in the other kinds, usually do not curve outward, and are not much bunched. When without seeds, *guadalupensis* resembles underwater forms of Water-starwort (page 61); but the leaves have sheathing bases.

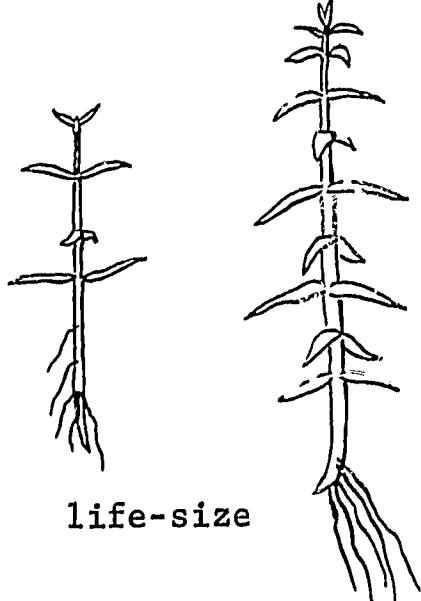
Najas minor.
Illinois to Vermont, Alabama, and Florida. A native of Eurasia which in the last forty years has become common in the tidal Hudson River and in artificial lakes. Leaves usually curve outward, and their marginal teeth are visible to the naked eye. Unlike the other kinds, its seeds are ribbed lengthwise.



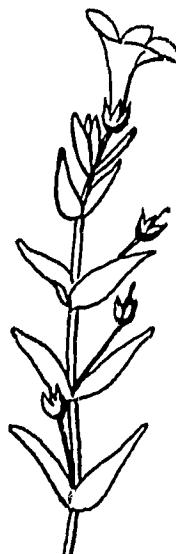
Najas guadalupensis,
half life-size



Najas minor,
half life-size



life-size



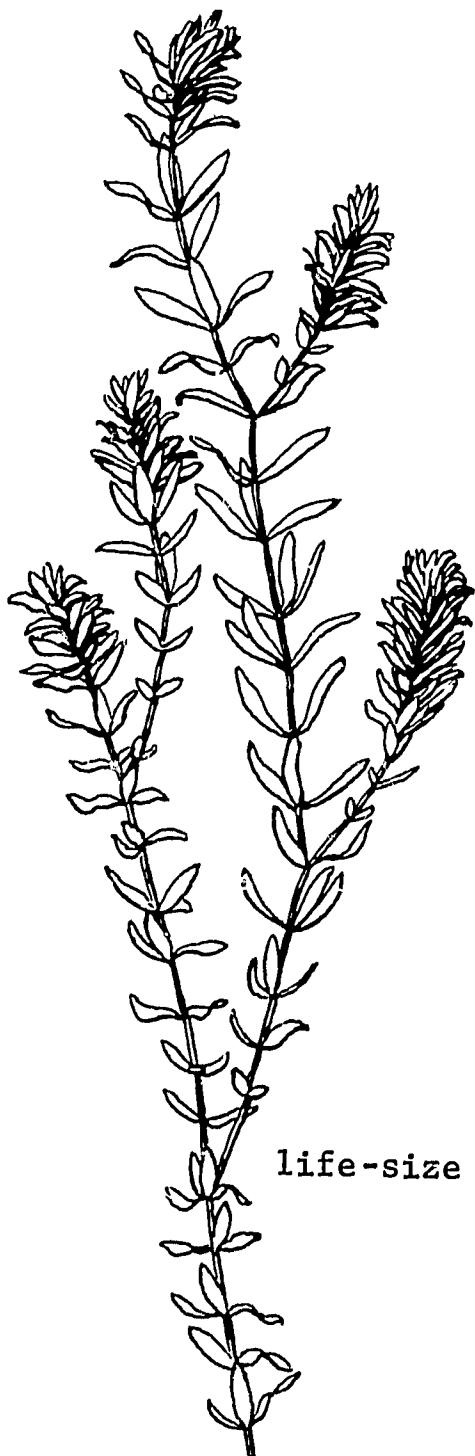
life-size

COMMON ELODEA, *Elodea canadensis*
(*Elodea nuttallii*; *Philotria canadensis* and *linearis*)

Fresh to slightly alkali inland water and fresh to slightly brackish coastal water; British Columbia to Quebec, California, and Florida.

Leaves vary greatly in width, size, and bunching; therefore plants are often slimmer or stouter than as pictured. Sometimes there are slim seed pods at the base of leaves.

Big plants resemble small plants of South American Elodea (page 68); but toward the tip of stems the leaves of Common are in twos or threes at a joint, those of South American are in fours or fives. Plants with narrow, limp leaves resemble underwater forms of Water-starworts (page 61); but Elodea leaves are bunched toward the tip of stems and usually are in threes at a joint. Resembles large plants of Micranthemum (page 70); but Elodea leaves are usually bunched at the end of branches.



life-size

GOLDENPERT, *Gratiola aurea*

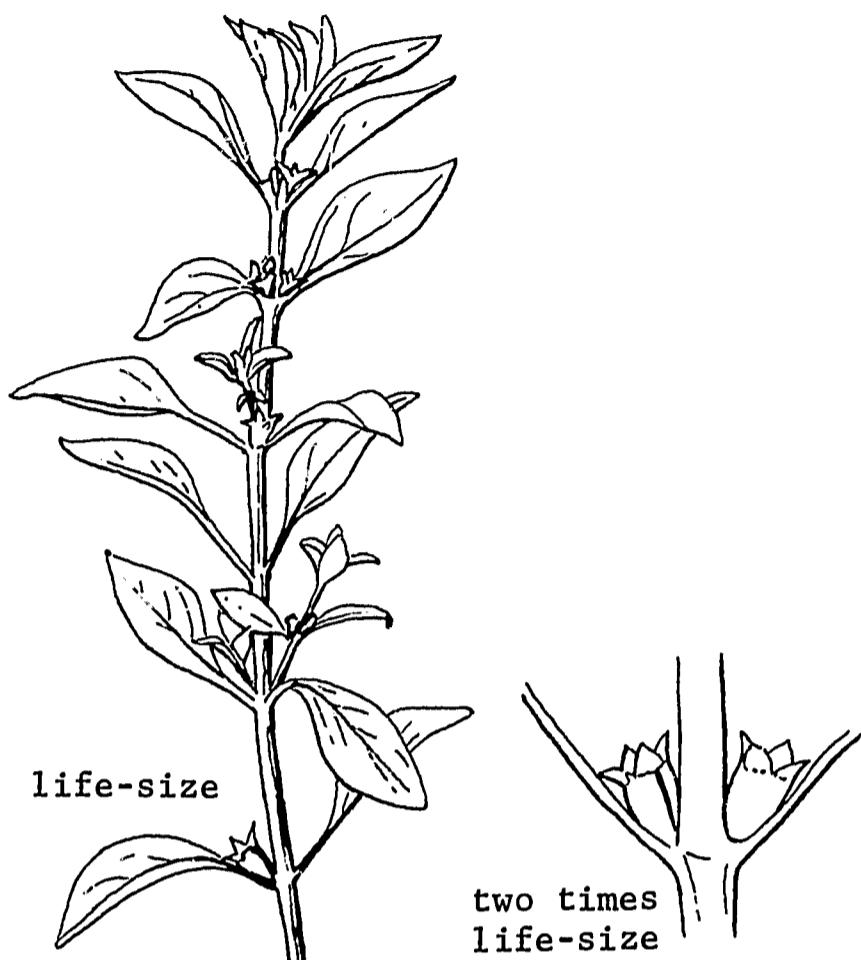
Fresh water; Wisconsin to Newfoundland, Alabama, and Florida (but only near the coast in the southeastern states).

Sometimes grows in several feet of water, where it is an inch or two high and has sharp-tipped leaves and no flowers. Usually grows out of water or partly out; then is bigger and has blunt-tipped leaves and yellow flowers.

MARSH-PURSLANE,
Ludwigia palustris
(*Ludwigia natans*; *Isnardia intermedia*, *palustris*, and *repens*)

Fresh water; British Columbia to Nova Scotia, California, and Florida.

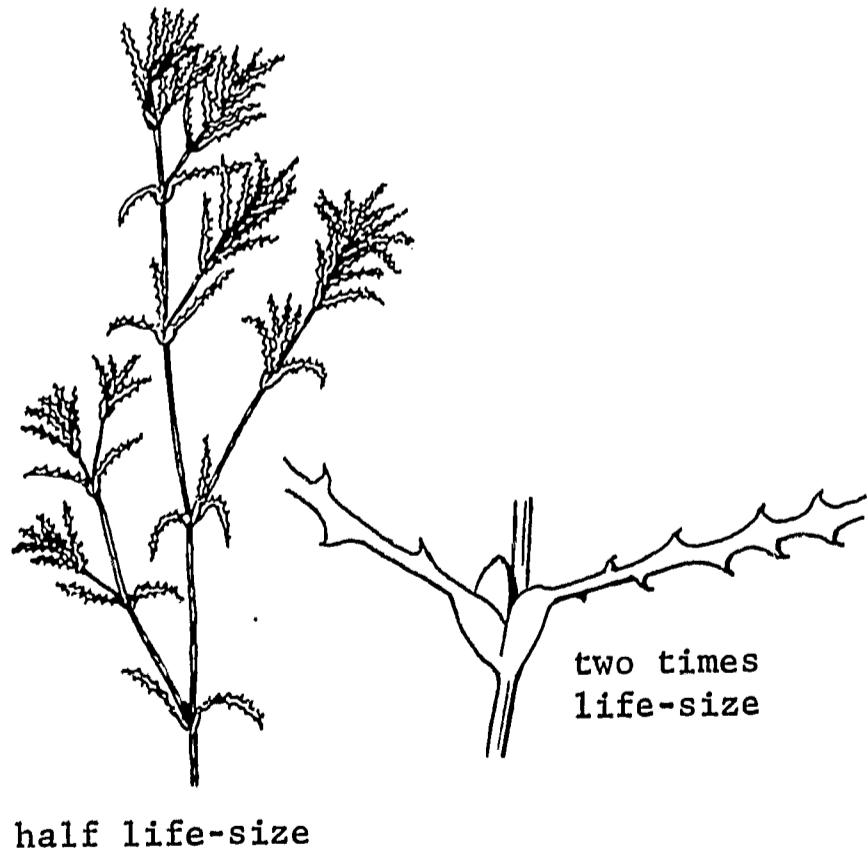
Usually sprawls on wet ground or partly under water; but sometimes in clear springs and spring-fed streams it has about the same appearance as when it grows out of water.

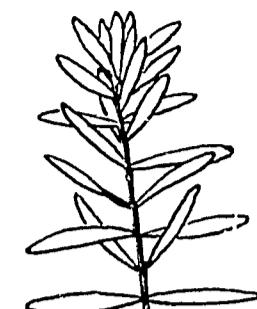
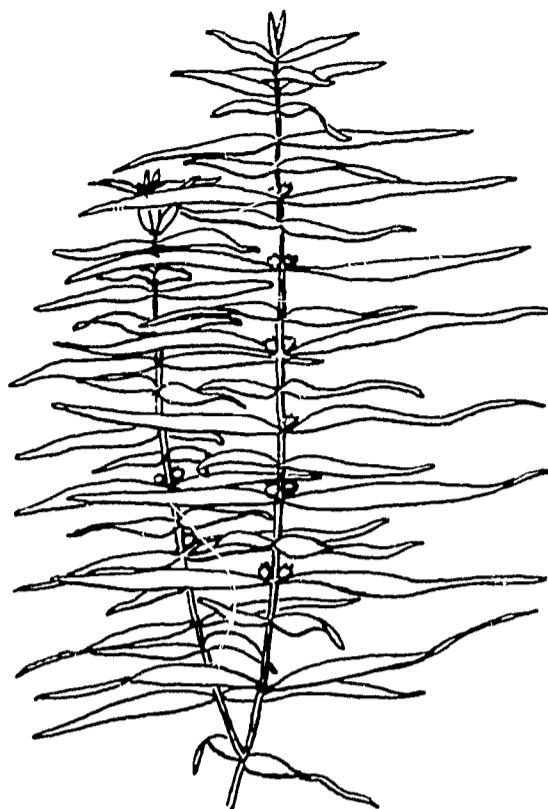


SPINY NAIAD, *Najas marina*
(*Najas gracilis*)

Fresh, brackish, and alkali inland water, and rarely brackish coastal water; California to Utah and Arizona; North Dakota to New York; southern Texas; and Florida.

Varies greatly in coarseness; but teeth are conspicuous on the leaves of even the smallest, slimmest plants.





life-size

**WATER-PURSLANE, *Peplis diandra*
(*Didiplis diandra*)**

Fresh water; Wisconsin to Virginia,
Texas, and Florida.

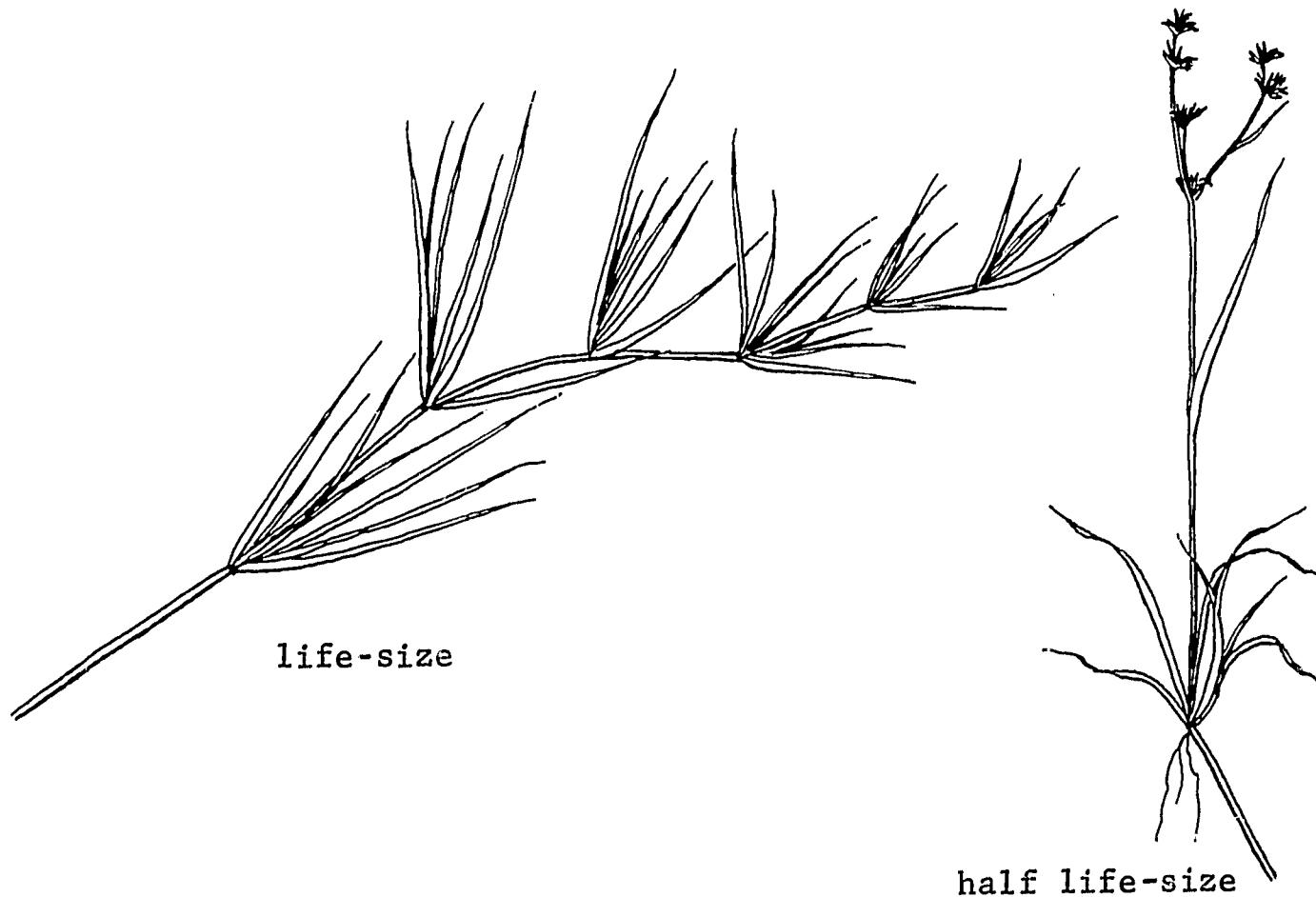
Under water or out of water. Underwater leaves are limp and ribbonlike.
Out-of-water leaves are stiffer and shorter. Often has ball-like seed pods,
less than 1/8 inch across, at the base
of leaves.

**SOUTH AMERICAN ELODEA, *Elodea densa*
(*Philotria densa*)**

This common aquarium plant has run wild in fresh inland and rarely coastal water from Oregon to Massachusetts, California, and Florida.

Usually in a branched tangle just under water.
Sometimes the 3-petaled flowers whiten a patch of surface.

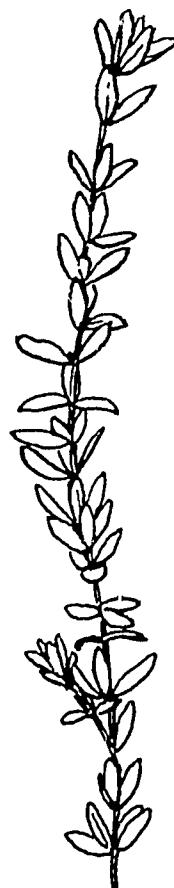
Small plants resemble big plants of Common Elodea (page 66); but toward the tip of stems the leaves of South American are in fours or fives at a joint, those of Common are in twos and threes.



CREEPING RUSH, *Juncus repens*

Fresh water; Oklahoma to Delaware, Texas, and Florida.

In mats under water, floating, or out of water. Stems are several times as wide as thick. Leaves and clusters of leaves are flat.



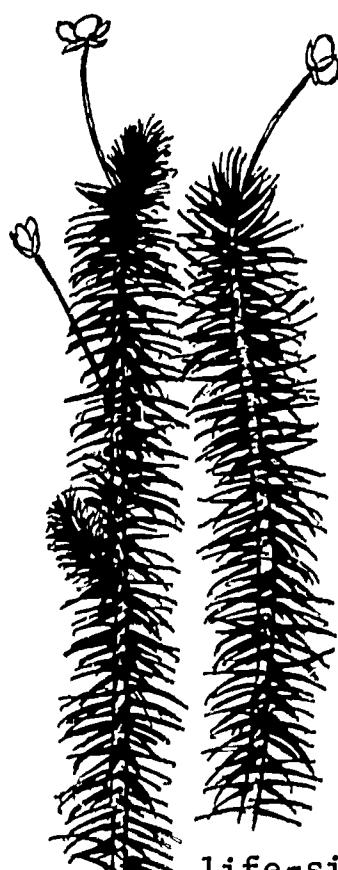
life-size

MICRANTHEMUM, *Micranthemum micranthemooides*
(*Hemianthus glomeratus*)

Fresh coastal water from New York to Virginia; and fresh inland and coastal water in Florida.

Grows under water or partly out of water; often under water at high tide. Varies from smaller than pictured to larger and more branched.

Large plants resemble Common Elodea (page 66); but *Micranthemum* leaves are usually not bunched at the end of branches.



life-size

MAYACA, *Mayaca fluviatilis*
(*Mayaca aubletii*)

Fresh water; North Carolina to Texas.

Under water or partly out of water. Has 3-petaled pink flowers.

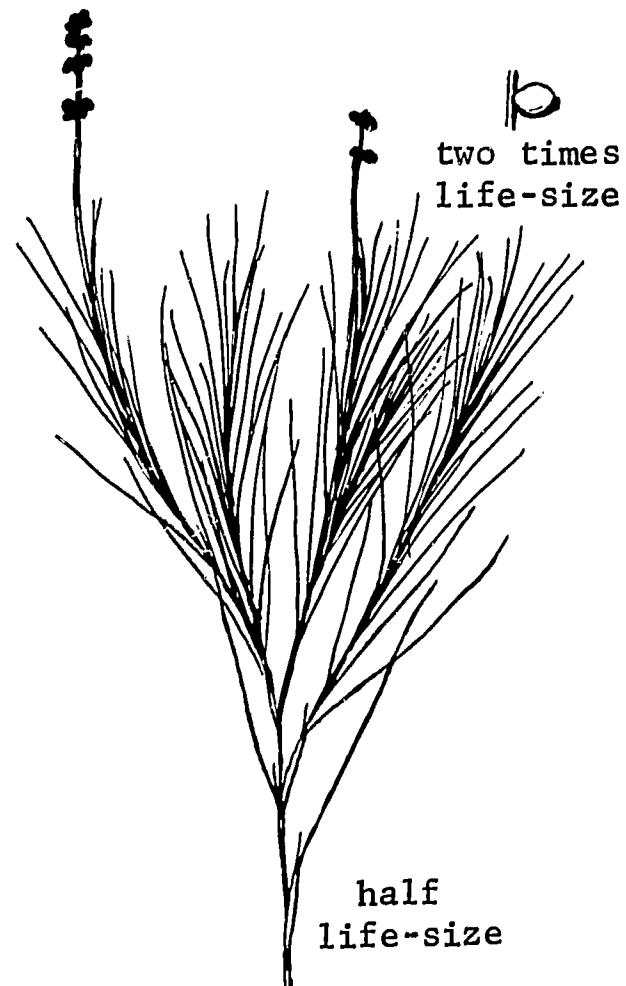
When not in bloom, resembles Bog Clubmoss.

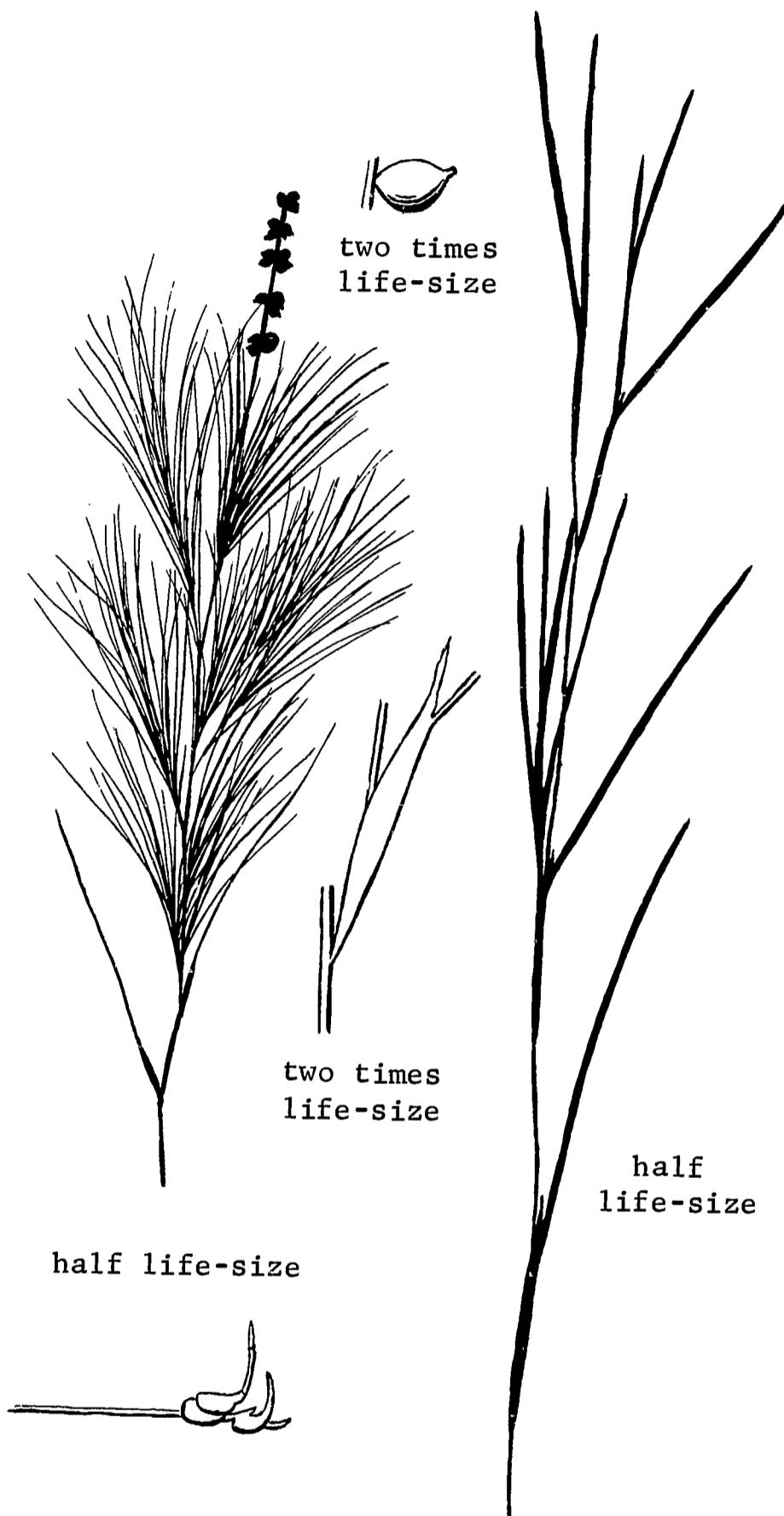
Group 7. PLANTS WITH THREADLIKE TO RIBBONLIKE LEAVES SCATTERED SINGLY ON FLEXIBLE UNDERWATER STEMS, BUT OFTEN PAIRED OR BUNCHED TOWARD THE STEM TIPS; A FEW KINDS ALSO WITH OBLONG TO OVAL FLOATING LEAVES grow in fresh inland water and in fresh to salt coastal water. The stems vary from upright to horizontal and from a few inches long to several feet; and usually they reach almost to the surface of the water, or even trail just beneath or on it. The underwater leaves collapse or partly collapse when taken out of water. In summer, Pondweeds produce small greenish or brownish flowers which are usually close together in oblong or ball-like spikes. In bloom, the upper spikes often stand above water; but when the seeds are ripe, the spikes are usually lying in water. Water-stargrass has scattered yellow flowers and slim seed pods. Widgeongrass has pondweed-like flowers which ripen a small cluster of long-stalked seeds.

THREADLEAF PONDWEED,
Potamogeton filiformis

Fresh inland water and fresh to slightly brackish coastal water; Alaska to Greenland, California, New Mexico, Minnesota, and Pennsylvania.

Resembles Sago Pondweed (page 72); but the stems are usually shorter, and the smaller seeds (a little less than 1/8 inch long) have a flattish, wart-like tip. Resembles Bigsheath Pondweed (page 74); but is smaller, all the leaves have narrow-sheathed bases, and the seed heads usually have only 3 or 4 clusters of seeds.

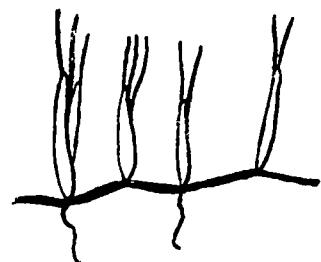
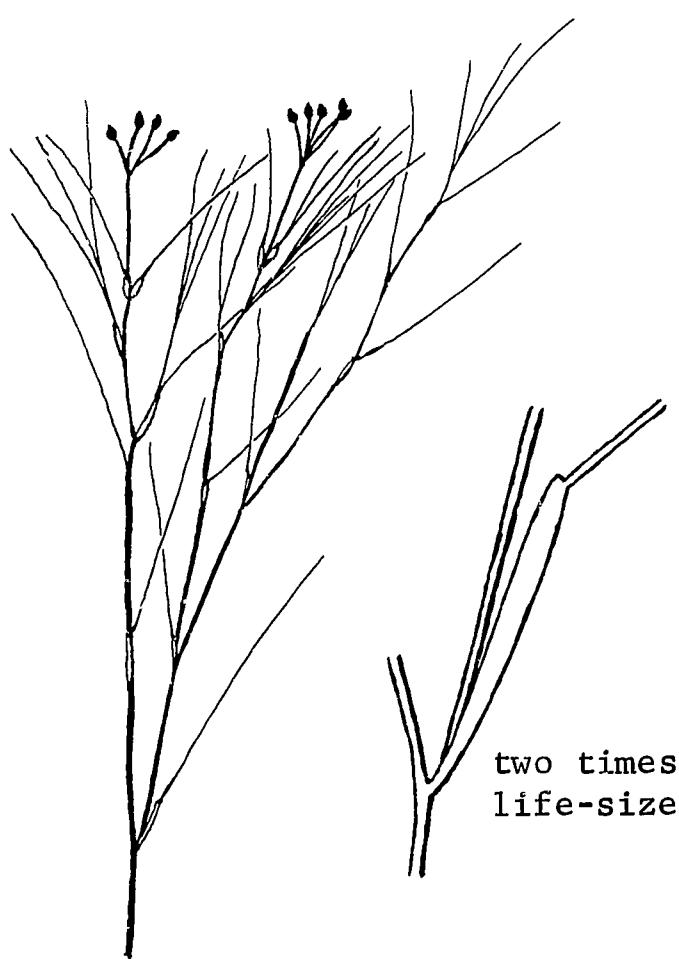




SAGO PONDWEED,
Potamogeton pectinatus

Fresh and alkali inland water and fresh to brackish coastal water; Alaska to Quebec, California, and Florida (but rare in the southeastern states).

Resembles Threadleaf Pondweed (page 71); but the stems are usually longer, and the larger seeds ($1/8$ inch long or more) have a pointed tip. Resembles Bigsheath Pondweed (page 74); but all the leaves have narrow-sheathed bases, and the seeds have a pointed tip. When not in bloom or seed, resembles non-seeding Widgeongrass (page 73); but the leaves are usually in bushier clusters, the sheathing base of the leaves has a tapering, flimsy tip, and the rootstocks are long and straight and often have tubers.



WIDGEONGRASS, *Ruppia maritima*
(*Ruppia occidentalis*)

Salt to fresh coastal water and alkali to fresh inland water; Alaska to Newfoundland, California, and Florida (but very rare inland in the eastern half of the continent).

When not in seed, resembles non-seeding Sago Pondweed (page 72); but the leaves are usually in less-bushy clusters, the sheathing base of the leaves has a rounded, firm tip, and the rootstocks are short and zigzag and have no tubers.



BIGSHEATH PONDWEED,
Potamogeton vaginatus

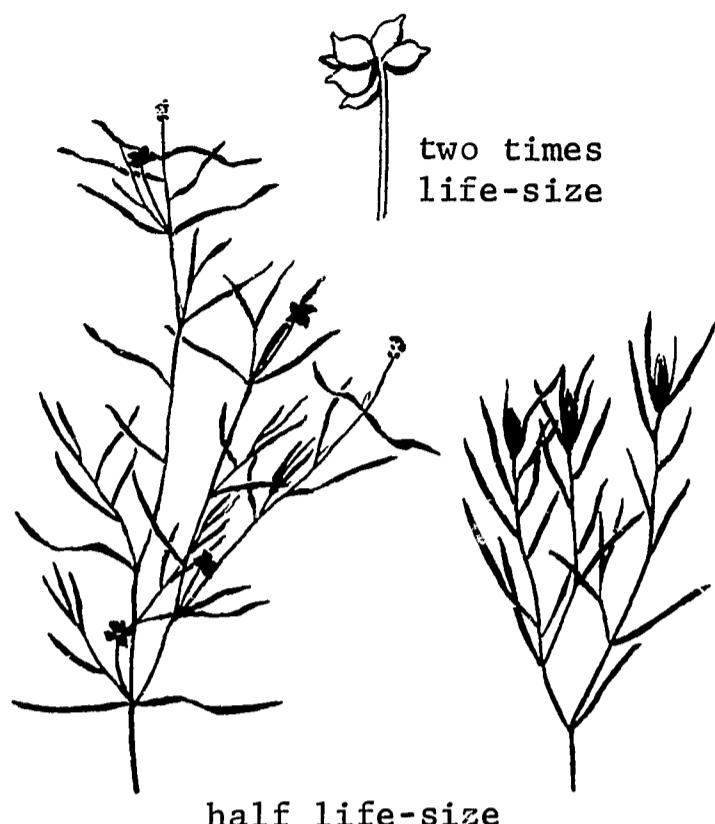
Fresh water;
Alaska to Quebec,
Oregon, Colorado, and
New York.

Resembles Sago
Pondweed (page 72);
but the sheathing
base of the main
leaves is two or more
times as wide as the
stem, and the seeds
have a flattish wart-
like tip. Resembles
Threadleaf Pondweed
(page 71); but is
bigger, the sheathing
base of the main
leaves is two or
more times as wide
as the stem, and the
heads usually have
6-10 clusters of
seeds.

SLENDER PONDWEED,
Potamogeton pusillus
(*Potamogeton berchtoldi*,
gemmae, and *lateralis*)

Fresh and alkali inland water and fresh and slightly brackish coastal water; Alaska to Greenland, California, and Florida.

Resembles Leafy Pondweed (page 77); but has longer-stalked seed heads and blunt-backed seeds. Resembles Fries Pondweed (below); but has smaller seeds (a little more than $1/16$ inch long) usually smaller leaves, and smaller, smooth-leaved winter-buds. Resembles the under-water form of Snailseed Pondweed (page 78); but has longer-stalked seed heads, convex-sided seeds, and leaves with non-sheathing base. Resembles the under-water form of Vasey Pondweed (page 80); but has bigger, fatter winterbuds.



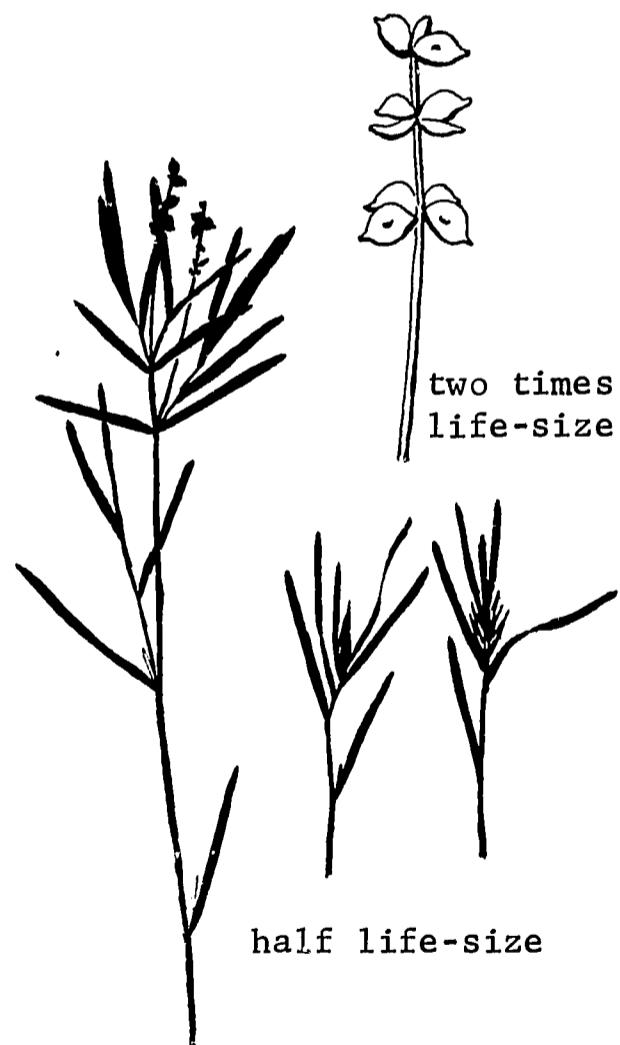
two times
life-size

half life-size

FRIES PONDWEED,
Potamogeton friesii
(*Potamogeton longiligulatus*
and *strictifolius*)

Fresh water; Northwest Territories to Newfoundland, Washington, Utah, and Virginia.

Resembles Slender Pondweed (above); but has bigger seeds (nearly $1/8$ inch long), usually bigger leaves, and bigger winter-buds with leaves corrugated at the base with raised veins. Resembles Bluntleaf and Leafy Pondweeds (page 77); but has longer-stalked, looser seed heads and blunt-backed seeds.



two times
life-size

half life-size

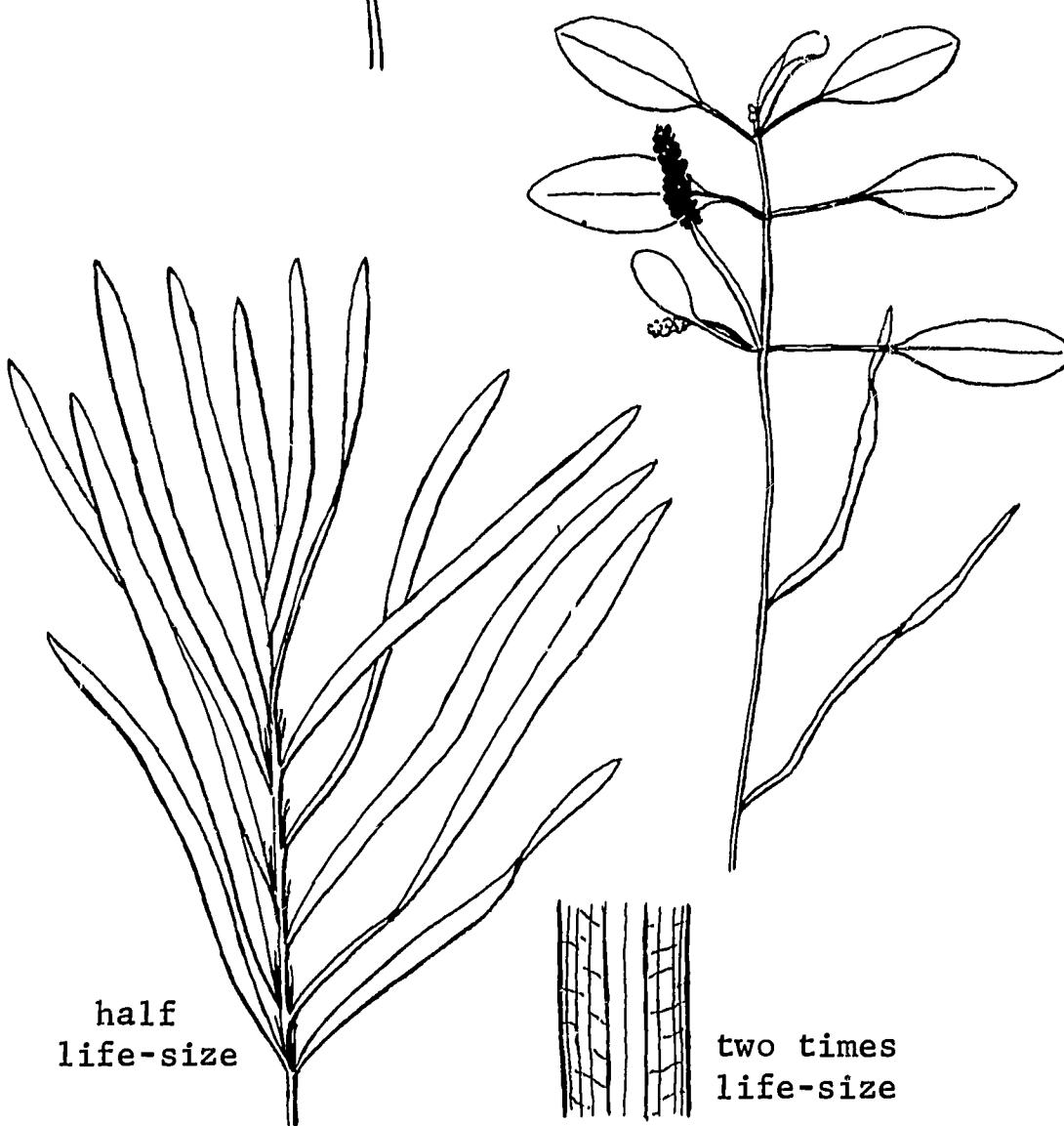


FLATSTEM PONDWEED,
Potamogeton zosteriformis

Fresh water, inland
and rarely coastal;
Alaska to Quebec, Cali-
fornia, Nebraska, and
Virginia.

Stems several times
as wide as thick.

When not in bloom,
resembles non-blooming
Water-stargrass (page 79);
but has leaves with
prominent midvein and
non-sheathing base.



RIBBONLEAF PONDWEED,
Potamogeton epihydrus

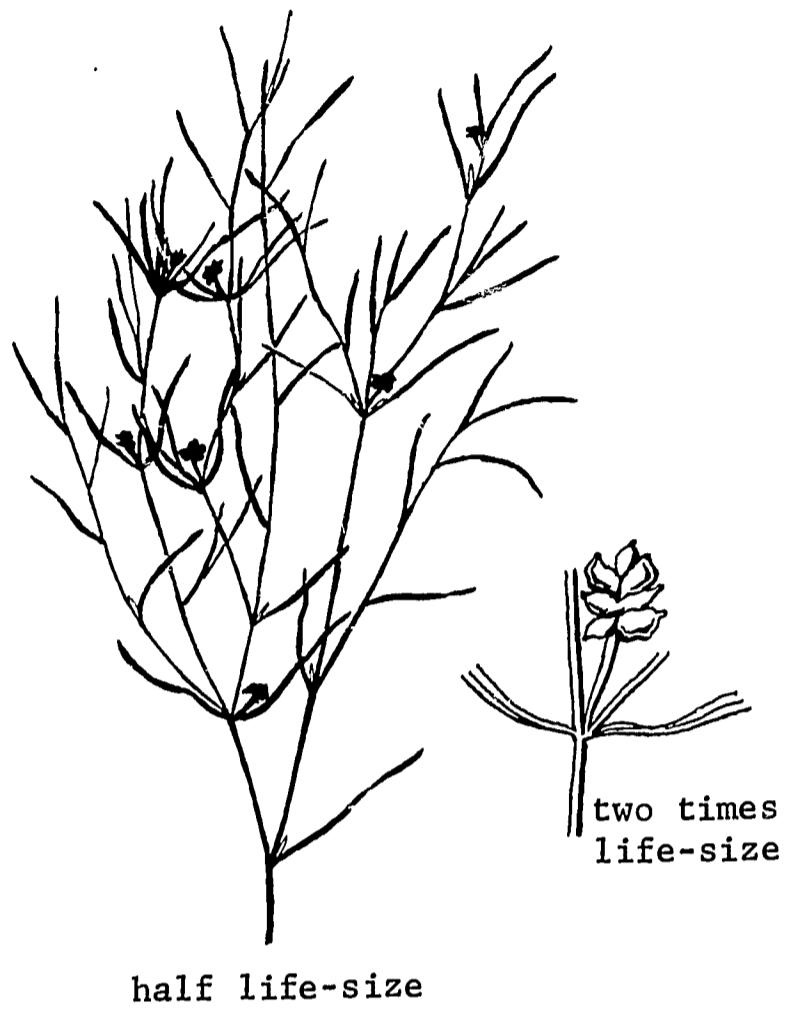
Fresh water,
inland, particularly
in slow streams, and
rarely coastal;
Alaska to Quebec,
California, Colo-
rado, and Georgia.

The very limp
underwater leaves
have a light-colored
center stripe.
Usually there are
floating leaves.

LEAFY PONDWEED,
Potamogeton foliosus
(*Potamogeton curtissii*, fibril-
losus, hillii, and porteri)

Fresh and alkali inland water and fresh and slightly brackish coastal water; Northwest Territories to Quebec, California, and Florida.

Resembles Slender and Fries Pondweeds (page 75); but has shorter-stalked seed heads, and seeds with a knife-edge back. Resembles Bluntleaf Pondweed (below); but has sharp-tipped, usually smaller leaves, and ball-like clusters of usually smaller seeds. Resembles the underwater form of Snailseed Pondweed (page 78); but Leafy's leaves do not have a sheathing base, and its seeds are not snail-like. Resembles the underwater form of Vasey Pondweed (page 80); but has bigger, fatter, winterbuds, shorter-stalked seed heads, and seeds with a knife-edge back.



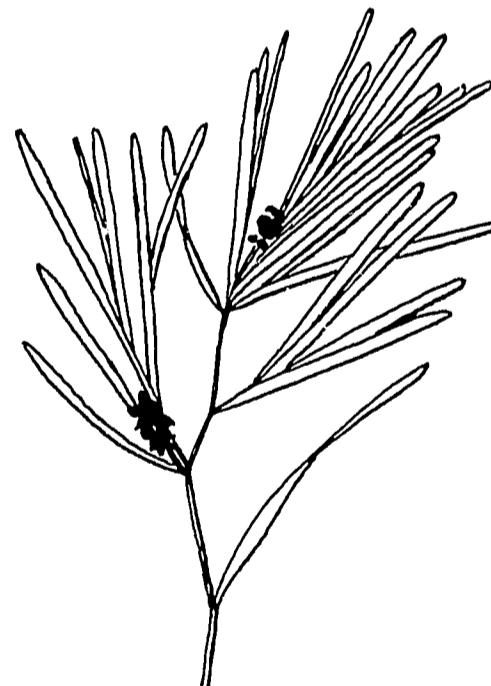
two times
life-size

half life-size

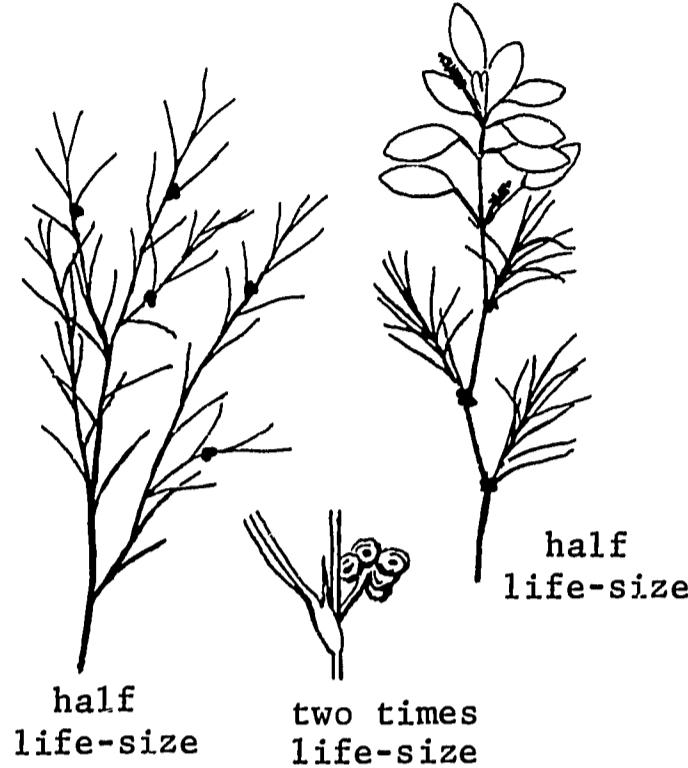
BLUNTLEAF PONDWEED,
Potamogeton obtusifolius

Fresh water, often in slow streams; Alaska to Quebec, Wyoming, Michigan, and New Jersey.

Resembles Leafy Pondweed (above); but has round-tipped, usually larger leaves, and oblong clusters of usually larger seeds. Resembles Fries Pondweed (page 75); but has shorter-stalked, denser seed heads, and larger (1/8 inch long or more), sharp-backed seeds.



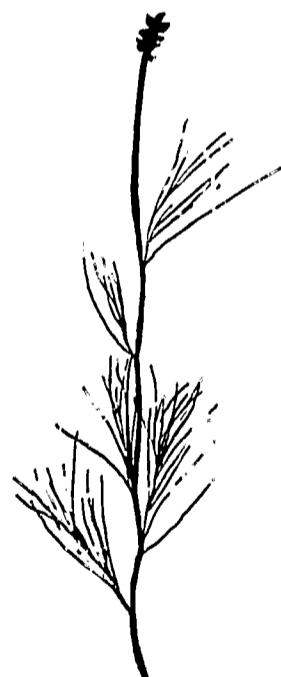
half life-size



**SNAILSEED PONDWEED,
Potamogeton diversifolius
(*Potamogeton bicupulatus*,
capillaceus, and *spirillus*)**

Fresh water, inland and rarely coastal; Montana to Newfoundland, California, and Florida.

Usually there are floating leaves. Without them, Snailseed Pondweed resembles Slender (page 75), Leafy (page 77), Vasey (page 80), and Alga (below) Pondweeds; but its leaf bases make a sheath around the stem, and it usually has several ball-like, almost stalkless underwater seed heads, with the seeds resembling tiny, flat snails.



**ALGA PONDWEED,
*Potamogeton conervoides***

Fresh water; Wisconsin to Newfoundland and New Jersey; and North Carolina.

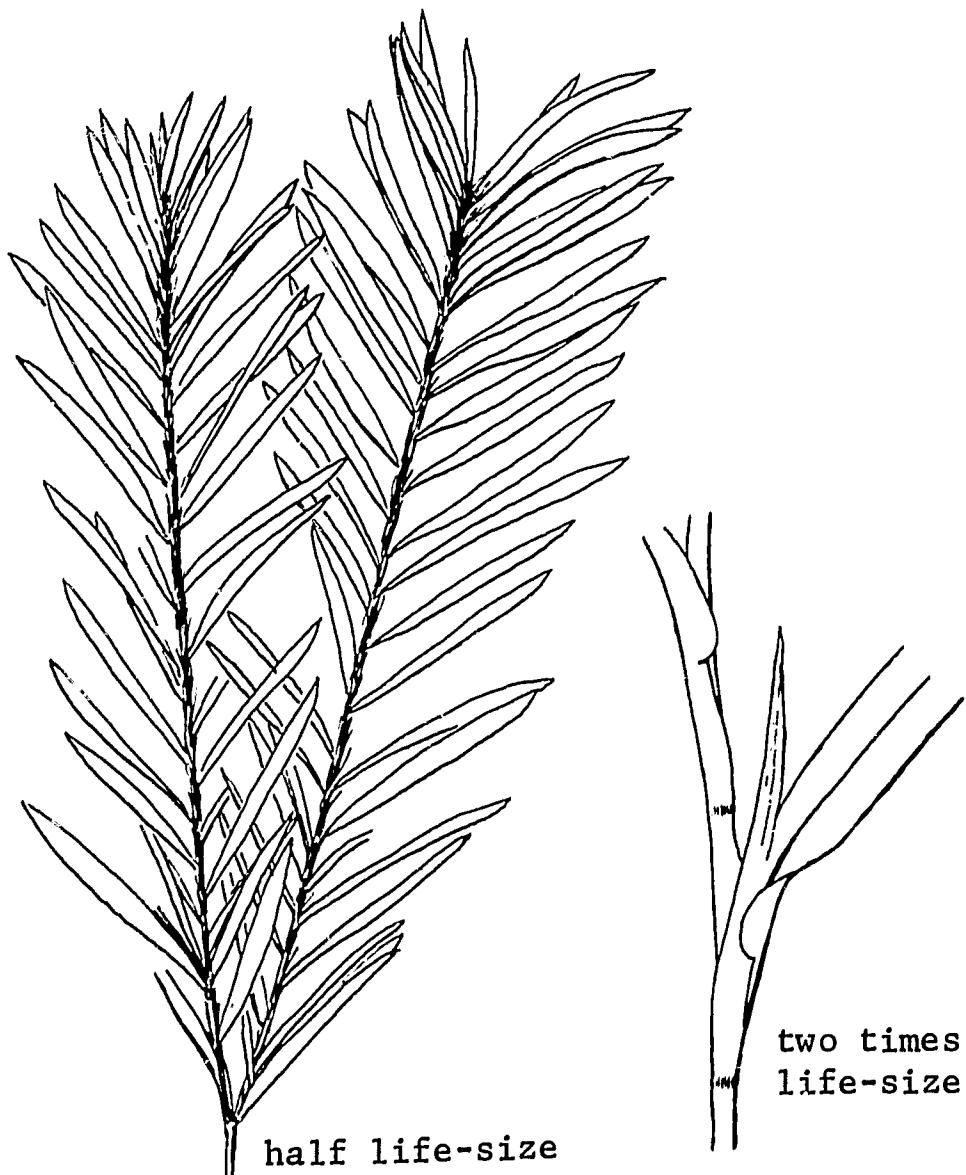
The bunched leaves are flimsy and hairlike.

Without seeds, it resembles the slimmest form of Snailseed Pondweed (above); but its leaves do not have a sheathing base.

FERN PONDWEED,
Potamogeton robbinsii

Fresh water, inland and rarely coastal; British Columbia to Wyoming, California, and Utah; Manitoba to Nova Scotia, Minnesota, and Virginia; and Alabama.

Leaf bases make a sheath around the stem. Often these are whitish, overlapping, and frayed into short threads. The form pictured grows in colonies with the tips of stems often a foot or more under water. A longer-stemmed, sprawly form has a less-fernlike look.

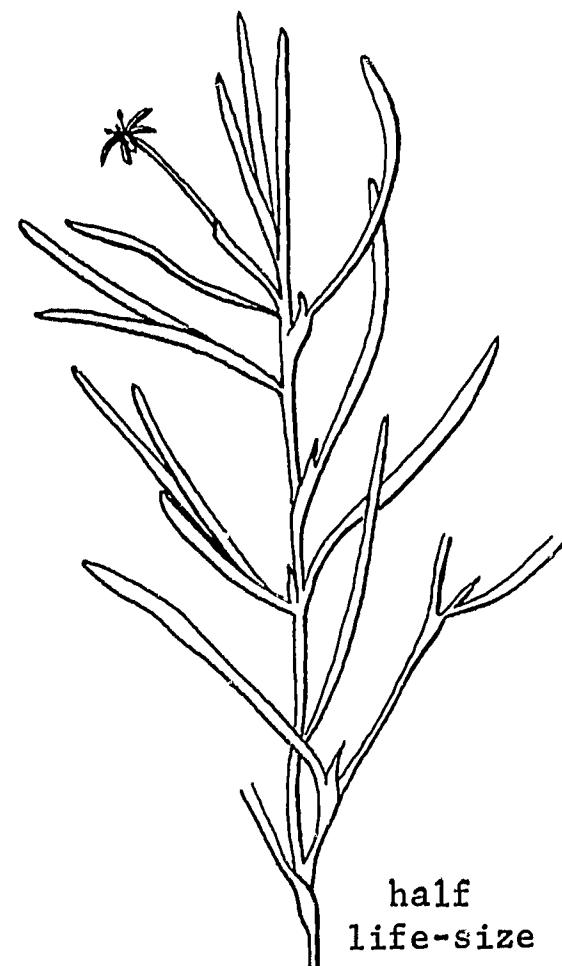


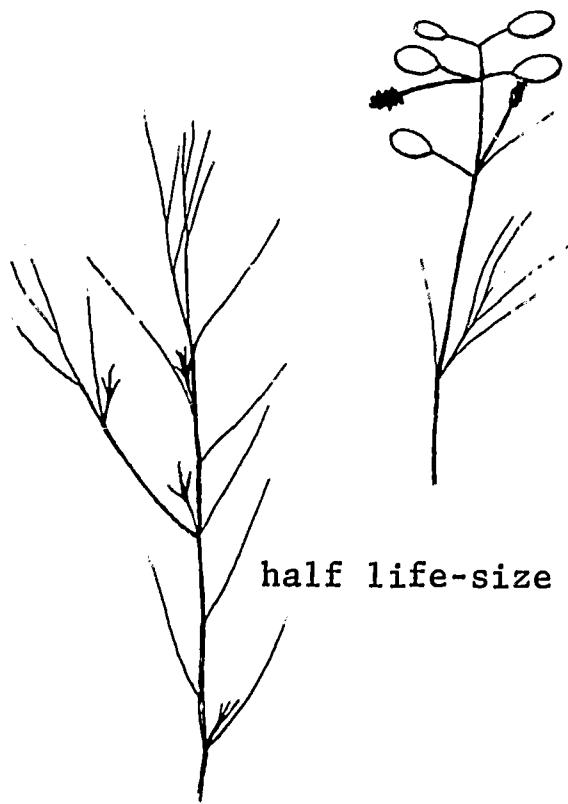
WATER-STARGRASS, *Heteranthera dubia*
(*Zosterella dubia*)

Fresh water, inland and rarely coastal; Washington to Quebec, California, and Florida (but rare from the Rockies west).

Yellow flowers are followed by slim pods with tiny seeds. Short plants sprawling on wet mud grow and bloom as well as longer ones do in water.

When not in bloom, resembles non-blooming Flatstem Pondweed (page 76); but has leaves without a noticeable midvein and with a base that makes a sheath around the stem.





VASEY PONDWEED, *Potamogeton vaseyi*

Fresh water; Minnesota to New Brunswick, Iowa, and Pennsylvania.

Leaves hairlike and with long-tapered tips. Often there are tiny winterbuds on short stalks at the base of leaves. Sometimes there are floating leaves.

When without floating leaves, Vasey Pondweed resembles the slimmest form of Slender Pondweed (page 75); but it has smaller, slimmer winterbuds.

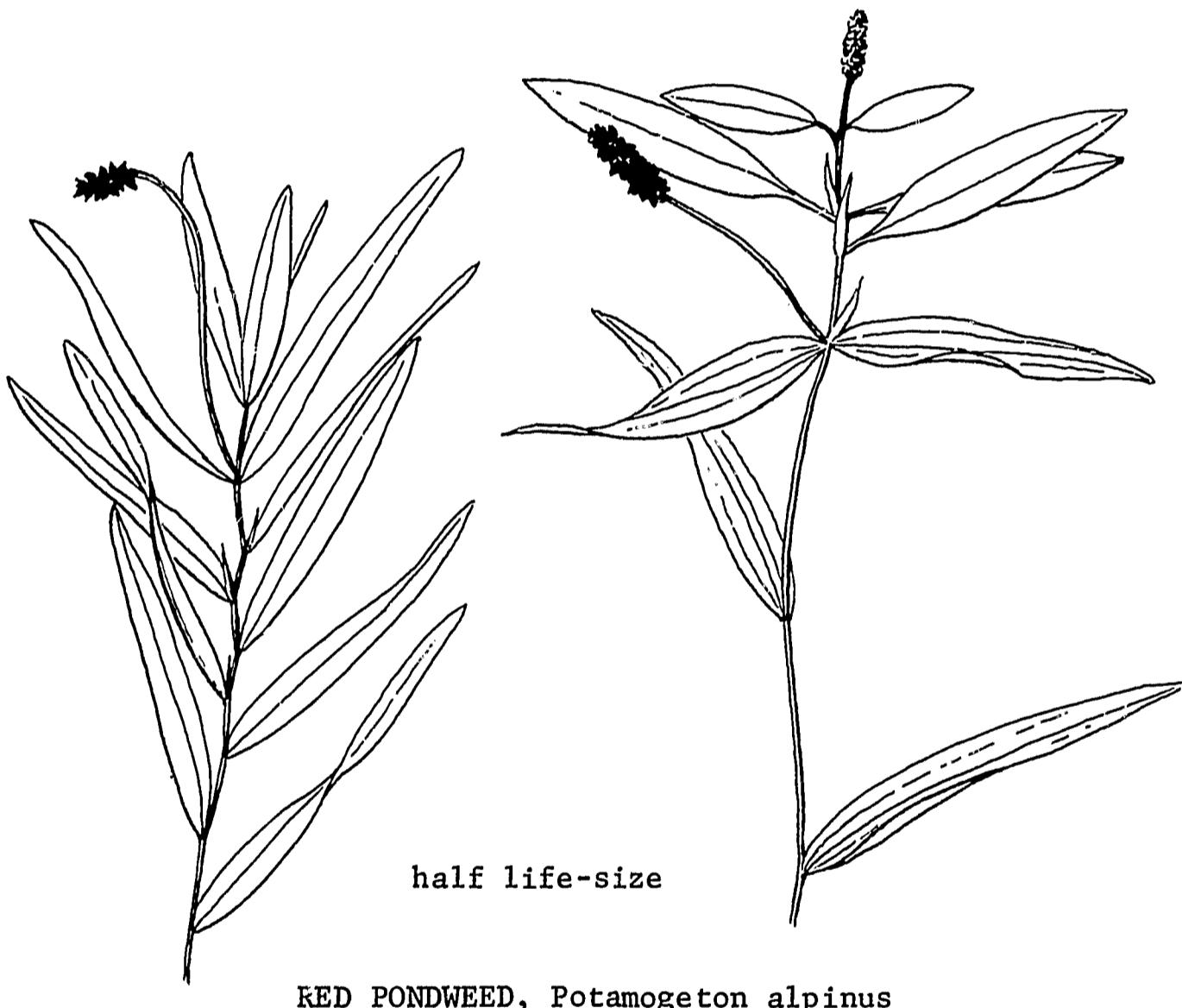


WESTERN PONDWEED,
Potamogeton latifolius

Alkali water; Oregon to California and Texas.

The short, ribbonlike, blunt-tipped leaves have a base which makes a sheath two or more times the width of the stem. Seed heads and seeds resemble those of Sago Pondweed (page 72).

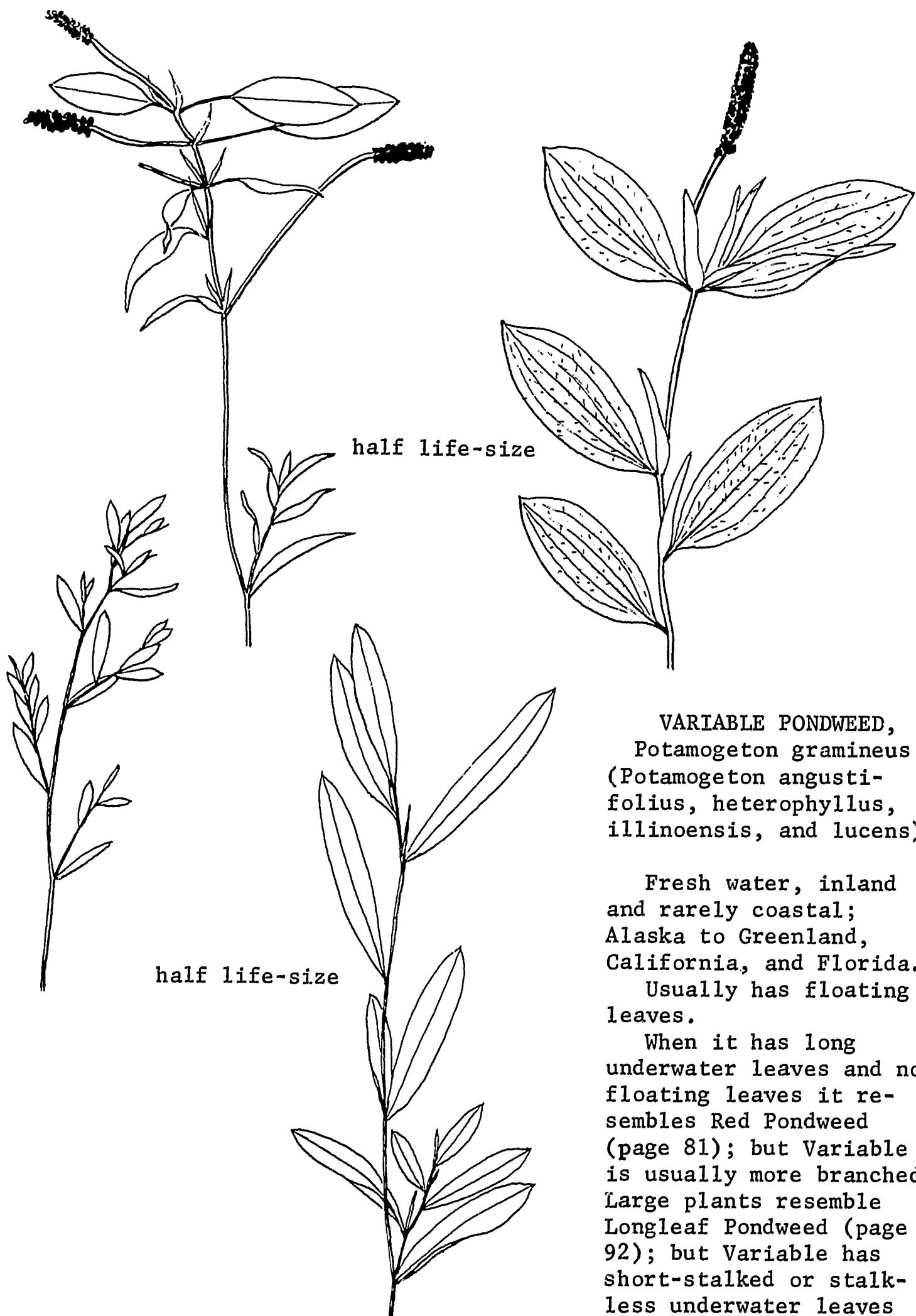
Group 8. PLANTS WITH LANCE-SHAPED TO OVAL LEAVES SCATTERED SINGLY ON FLEXIBLE UNDERWATER STEMS, BUT OFTEN PAIRED OR BUNCHED TOWARD THE STEM TIPS; SOME KINDS ALSO WITH OBLONG TO OVAL FLOATING LEAVES grow in fresh inland water and in fresh to brackish coastal water. The stems vary from upright to horizontal; frequently are several feet long; and are usually branched. Usually they reach almost to the surface of the water; and Red, Variable, and Bigleaf Pondweed stems are often tipped with floating leaves. In summer, these Pondweeds produce small greenish or brownish flowers which are close together in oblong spikes. In bloom, the spikes often stand above water; but when the seeds are ripe the spikes are usually lying in water.



RED PONDWEED, *Potamogeton alpinus*

Fresh water, often in slow streams; Alaska to Greenland, California, Colorado, Wisconsin, and Pennsylvania.

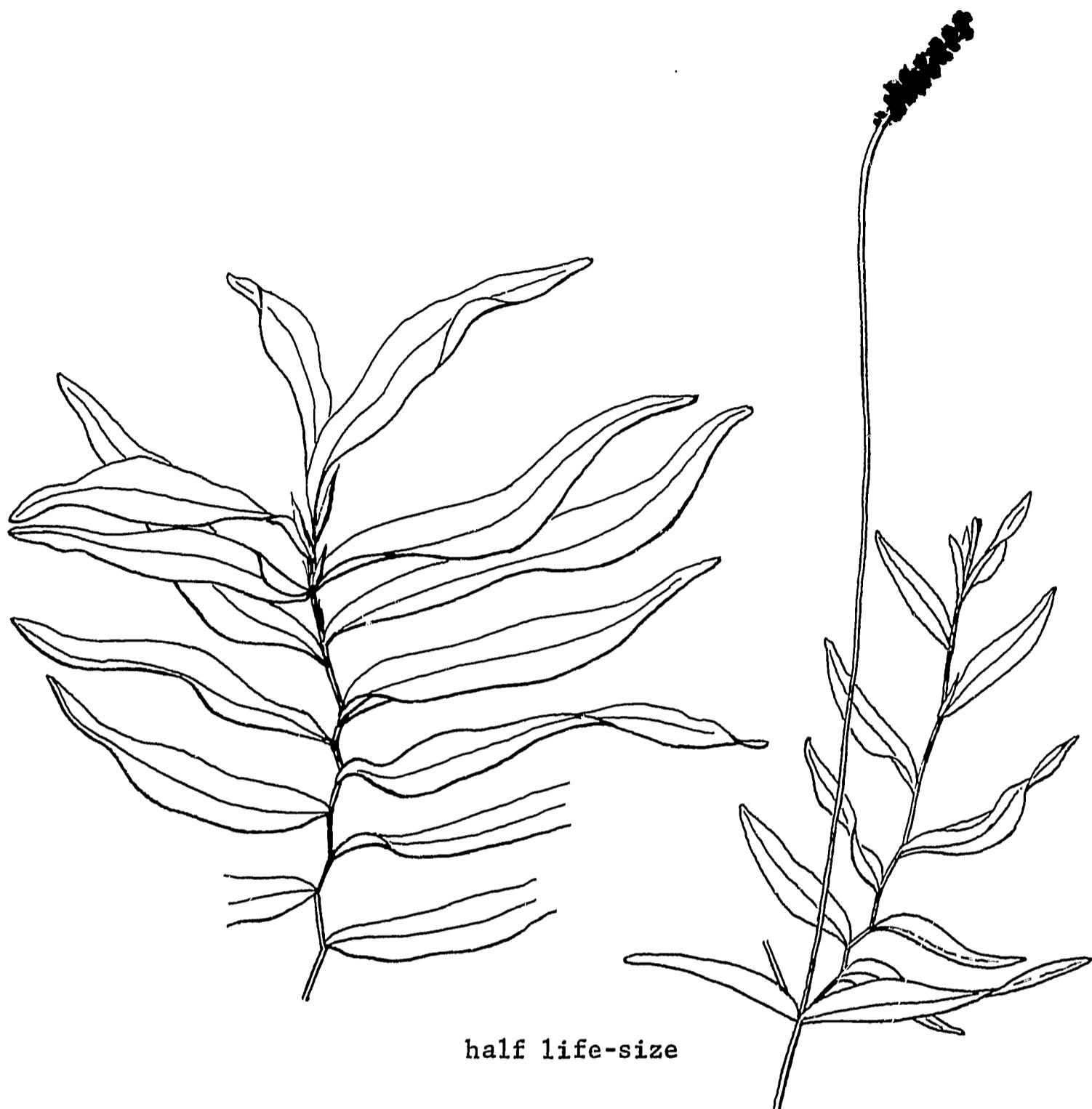
Plants are usually reddish. Sometimes they have floating leaves. Resembles plants of Variable Pondweed (page 82) with long underwater leaves and no floating leaves; but Red Pondweed is usually only a little branched.



VARIABLE PONDWEED,
Potamogeton gramineus
(*Potamogeton angustifolius*, *heterophyllus*,
illinoensis, and *lucens*)

Fresh water, inland
and rarely coastal;
Alaska to Greenland,
California, and Florida.
Usually has floating
leaves.

When it has long
underwater leaves and no
floating leaves it re-
sembles Red Pondweed
(page 81); but Variable
is usually more branched.
Large plants resemble
Longleaf Pondweed (page
92); but Variable has
short-stalked or stalk-
less underwater leaves
which are not long-
tapered at the tip.

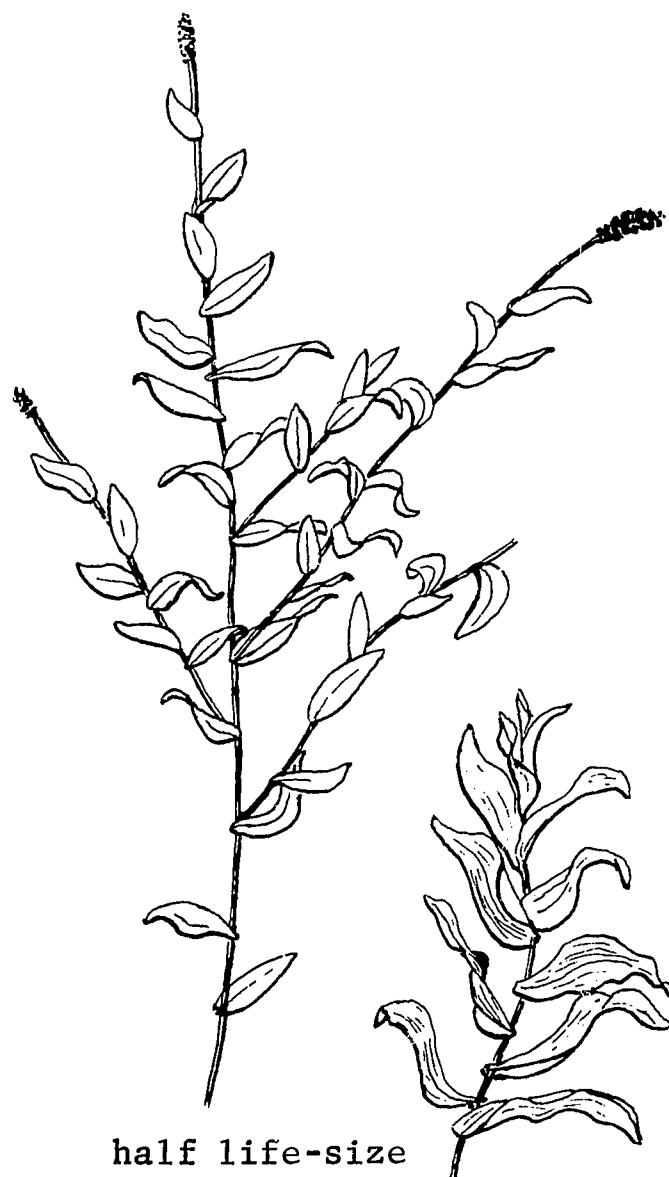


WHITESTEM PONDWEED, *Potamogeton praelongus*

Fresh water; Alaska to Newfoundland, California, Colorado, and New Jersey.

Leaves sometimes puckered.

Resembles long-leaved plants of Redhead-grass (page 84); but Whitestem's leaves have a hooded tip which splits a little way back when it is flattened, the upper part of stems is usually zigzag, the seed heads are long-stalked, and the sharp-backed seeds are about 3/16 inch long.



**REDHEAD-GRASS, *Potamogeton perfoliatus*
(*Potamogeton richardsonii*)**

Fresh inland water; Alaska to Newfoundland, California, Arizona, Nebraska, and New Jersey. And fresh to brackish coastal water; Newfoundland to Texas (but rare south of North Carolina).

Leaves vary from oval and flat to lance-shaped and puckered.

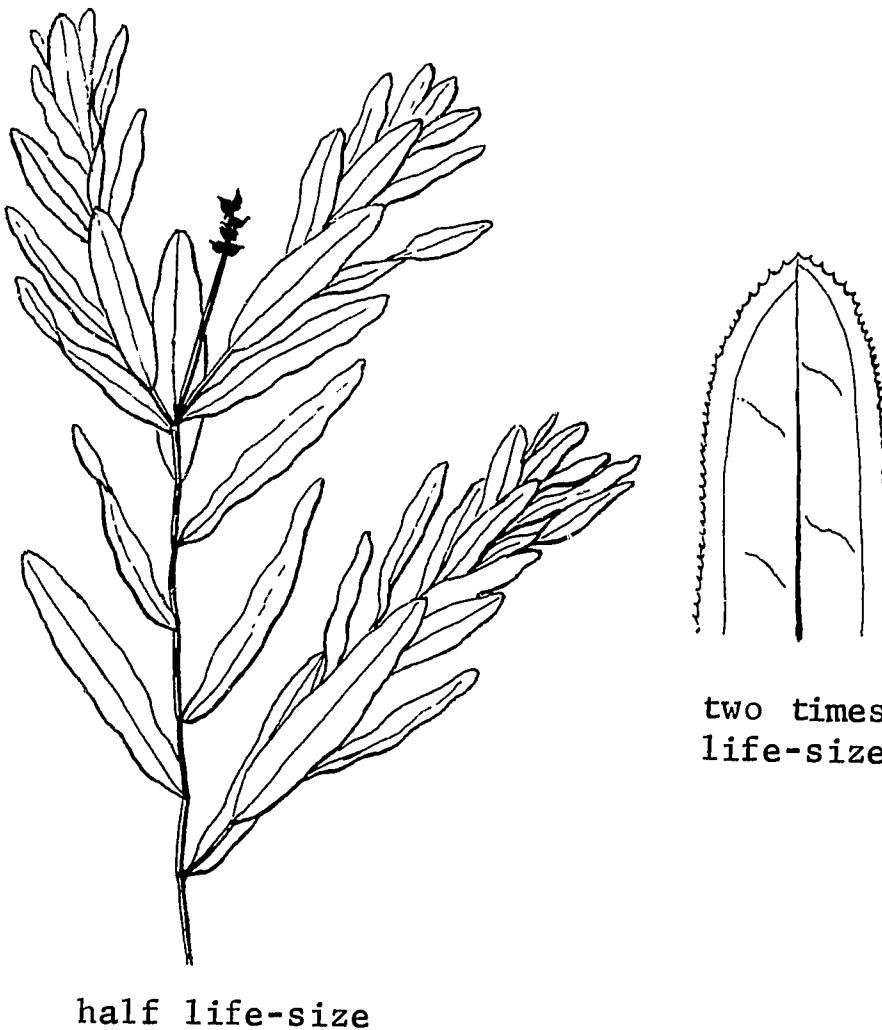
Long-leaved plants resemble Whitestem Pondweed (page 83); but the leaves have a flat tip, the upper part of stems is usually straight, the seed heads are short-stalked, and the blunt-backed seeds are about 1/8 inch long.



BIGLEAF PONDWEED, *Potamogeton amplifolius*

Fresh water, inland and rarely coastal; British Columbia to Newfoundland, California, Oklahoma, and Georgia (but rare in the Rockies and Great Basin).

Underwater leaves are usually strongly-arched lengthwise.
Usually there are floating leaves.



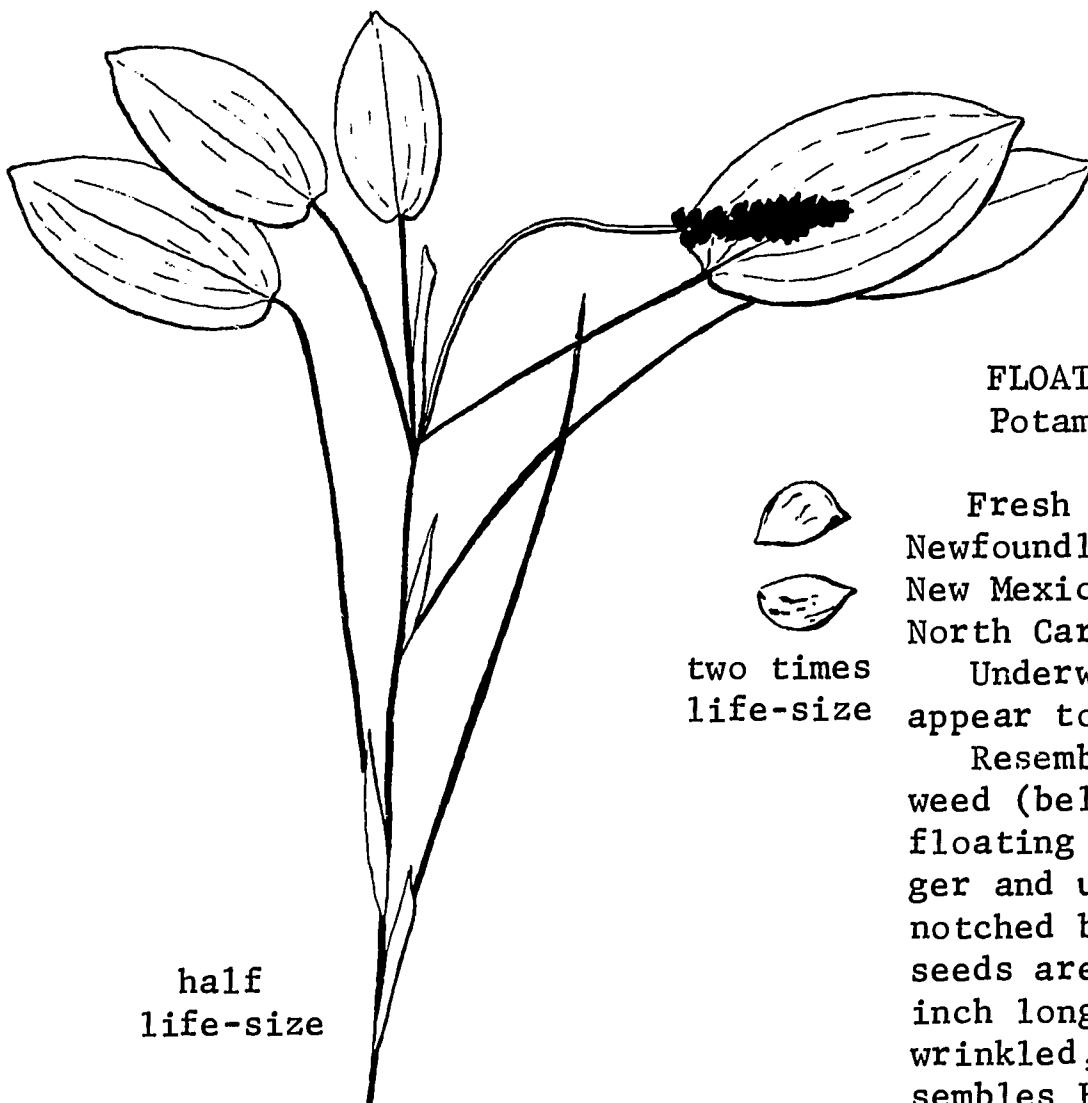
half life-size

two times
life-size

CURLY PONDWEED, *Potamogeton crispus*

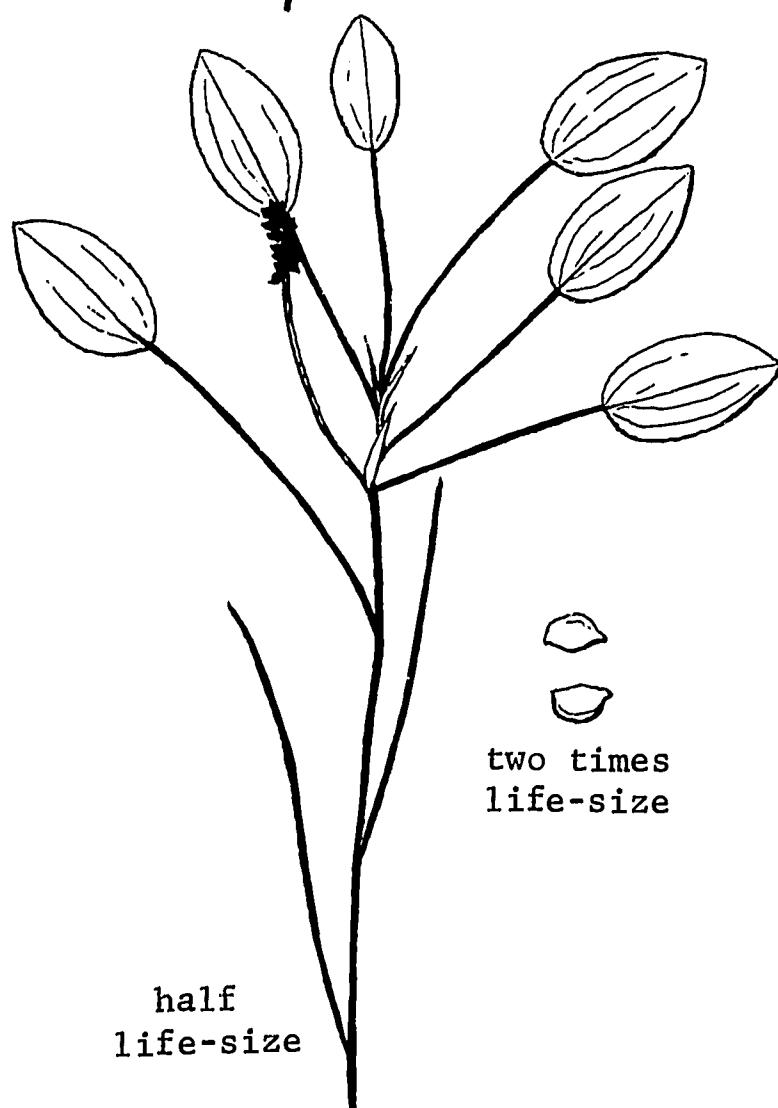
Fresh inland water and fresh to slightly brackish coastal water; Alberta to Quebec, California, and Florida. This native of the Old World has been in North America for at least 150 years and is still spreading. Leaves have finely-toothed, usually puckered edges.

Group 9. PLANTS WITH LANCE-SHAPED TO ROUND FLOATING LEAVES WHICH ARE TAPERED TO SLIGHTLY NOTCHED AT THE BASE; SOME KINDS ALSO WITH THREADLIKE TO OVAL UNDERWATER LEAVES; AND SOME KINDS ALSO GROWING PARTLY OUT OF WATER grow in fresh inland water and in fresh coastal water. The leaves of some kinds are on flexible, upright to horizontal stems; others have leaves in clumps on the bottom or coming up from rootstocks. Flowers vary from the inconspicuous ones of Pondweeds to the showy yellowish ones of American Lotus.



FLOATING PONDWEED,
Potamogeton natans

Fresh water; Alaska to Newfoundland, California, New Mexico, Illinois, and North Carolina.
Underwater leaves appear to be mere stalks. Resembles Oakes Pondweed (below); but the floating leaves are bigger and usually have a notched base, and the seeds are more than 1/8 inch long and have a wrinkled, shiny skin. Resembles Heartleaf Pondweed (page 94); but the floating leaves are usually widest about half way from the base to the tip, there are no widened underwater leaves, and the seeds are shiny and are blunt on the back.



OAKES PONDWEED,
Potamogeton oakesianus

Fresh water; Ontario to Newfoundland, Wisconsin, and Virginia.
Underwater leaves appear to be mere stalks. Resembles Floating Pondweed (above); but the floating leaves are smaller and have a rounded or tapering base, and the seeds are about 1/8 inch long and have a tight, dull skin.



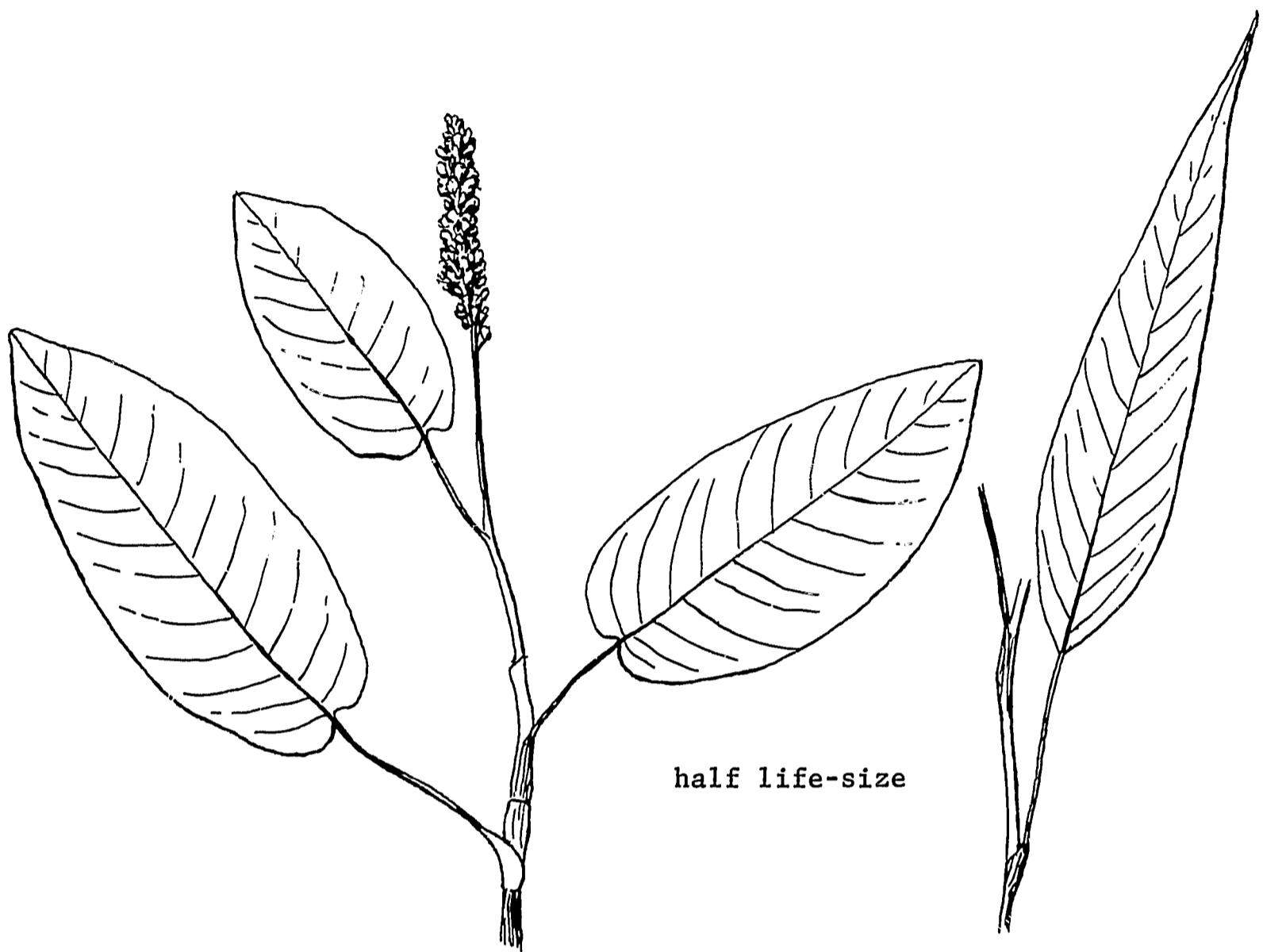
half life-size

WATER SMARTWEED, *Polygonum amphibium*
(*Polygonum natans*)

Fresh water; Alaska to Quebec, California, Illinois,
and New Jersey.

Heads of pink flowers stand above water. An upright
form grows in wet soil or reaches high above shallow water.

Resembles Marsh Smartweed (page 90); but the shorter
clusters of flowers are on hairless stalks, and the leaves
are smaller and narrower.



half life-size

MARSH SMARTWEED, *Polygonum coccineum*
(*Persicaria muhlenbergii*)

Fresh water; British Columbia to Quebec, California,
Texas, and South Carolina.

Heads of pink flowers stand above water. A commoner,
upright form grows in wet soil or reaches high above shallow
water.

Resembles Water Smartweed (page 89); but the longer
clusters of flowers are on fine-hairy stalks, and the
leaves are bigger and wider.

BOG PONDWEED,
Potamogeton oblongus

Fresh water;
Newfoundland to Nova
Scotia.

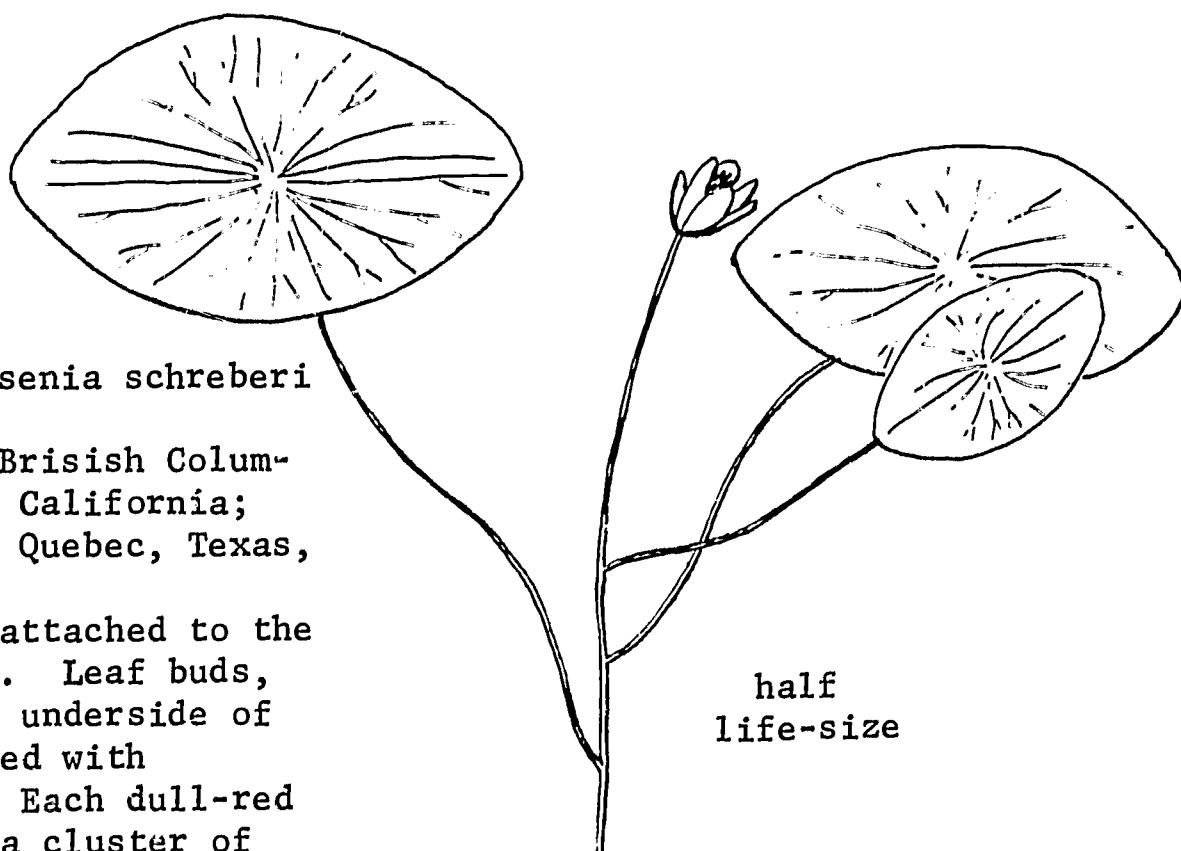
Seeds are red,
nearly round in side
view, and a little
more than 1/16 inch
long.



WATERSHIELD, *Brasenia schreberi*

Fresh water; British Colum-
bia to Idaho and California;
and Minnesota to Quebec, Texas,
and Florida.

The stalk is attached to the
middle of a leaf. Leaf buds,
flower buds, and underside of
leaves are covered with
slippery jelly. Each dull-red
flower produces a cluster of
pods which contain one or two
seeds apiece.





LONGLEAF PONDWEED, *Potamogeton nodosus*
(*Potamogeton fluitans*)

Fresh, often flowing water, inland and rarely coastal; British Columbia to New Brunswick, California, and Florida.

Resembles large plants of Variable Pondweed (page 82); but Longleaf has long-stalked underwater leaves which are long-tapered at the tip.

BROADLEAF WATERPLANTAIN,
Alisma plantago-aquatica
(*Alisma subcordatum* and
triviale)

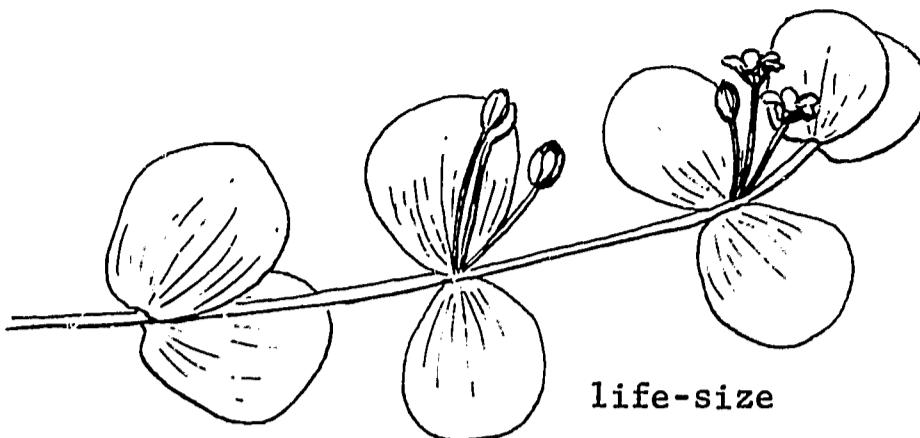
Fresh water; British Columbia to Nova Scotia, California, and Florida.

Clustered early leaves often float. Later leaves stand above water or mud around one or more loose flower heads.

Early leaves resemble those of Upright Burhead (page 96); but mature plants have sharp-tipped leaves and little circles of flattish, round-tipped seeds. Out-of-water plants resemble Narrowleaf Waterplantain (page 9); but the leaves usually have a blunt or notched base, and the clusters of flowers are longer than the leaves.



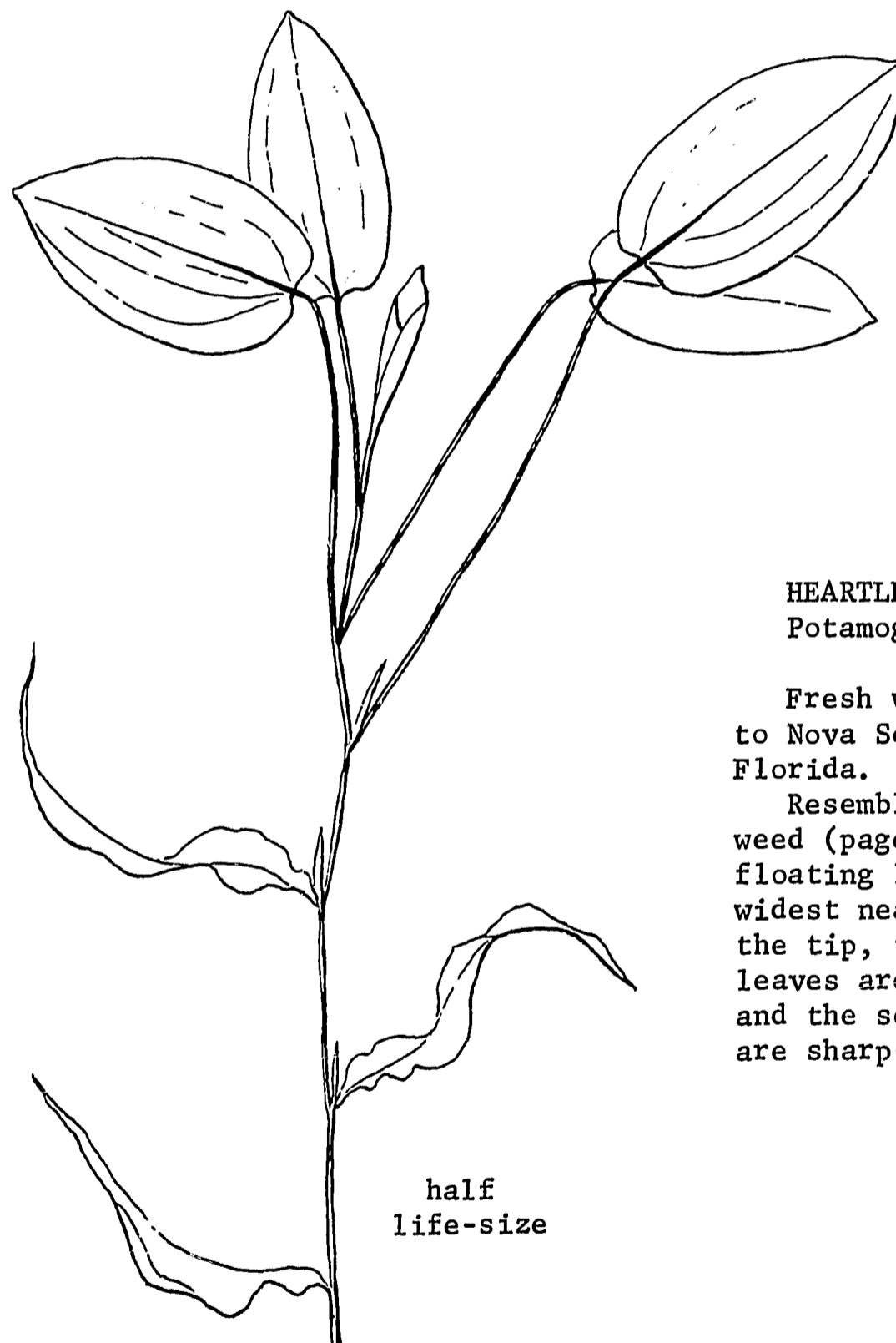
half life-size



life-size

ROUNDLEAF BACOPA,
Bacopa rotundifolia
(*Bacopa eisenii* and
nobsiana; *Macuillamia*
rotundifolia)

Fresh water; British
Columbia to Manitoba,
California, Louisiana,
and North Carolina.
Flowers are white.

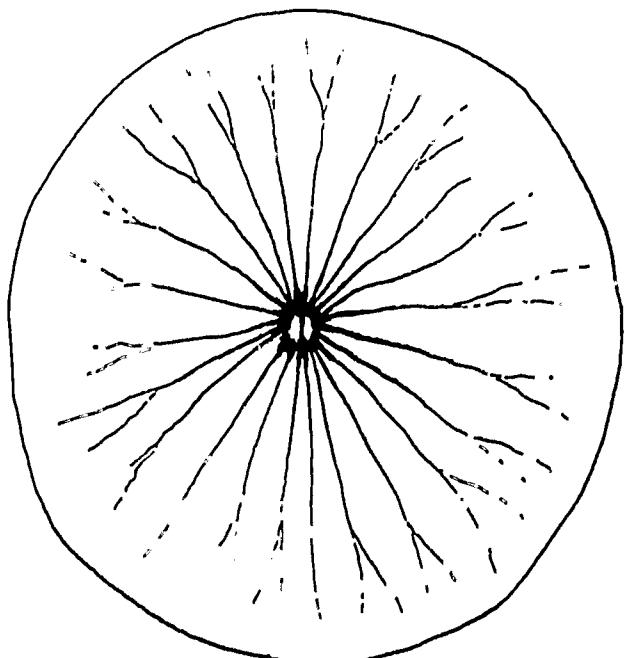


half
life-size

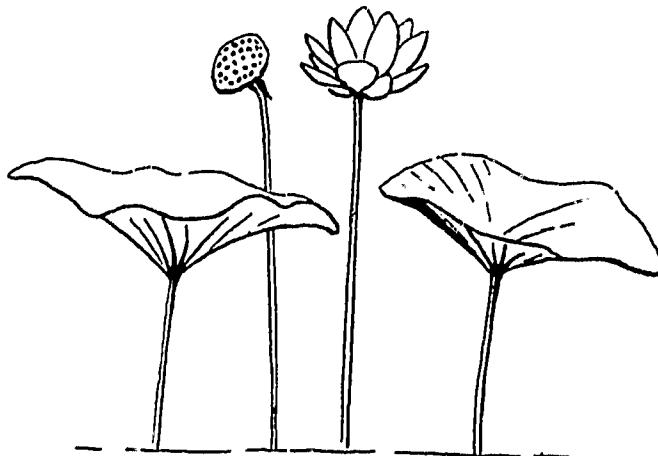
HEARTLEAF PONDWEED,
Potamogeton pulcher

Fresh water; Minnesota
to Nova Scotia, Texas, and
Florida.

Resembles Floating Pond-
weed (page 88); but the
floating leaves are usually
widest nearer the base than
the tip, the underwater
leaves are lance-shaped,
and the seeds are dull and
are sharp-backed.



quarter life-size



sixteenth life-size

AMERICAN LOTUS, *Nelumbo lutea*

Fresh water, inland and rarely coastal; Minnesota to Massachusetts, Texas, and Florida.

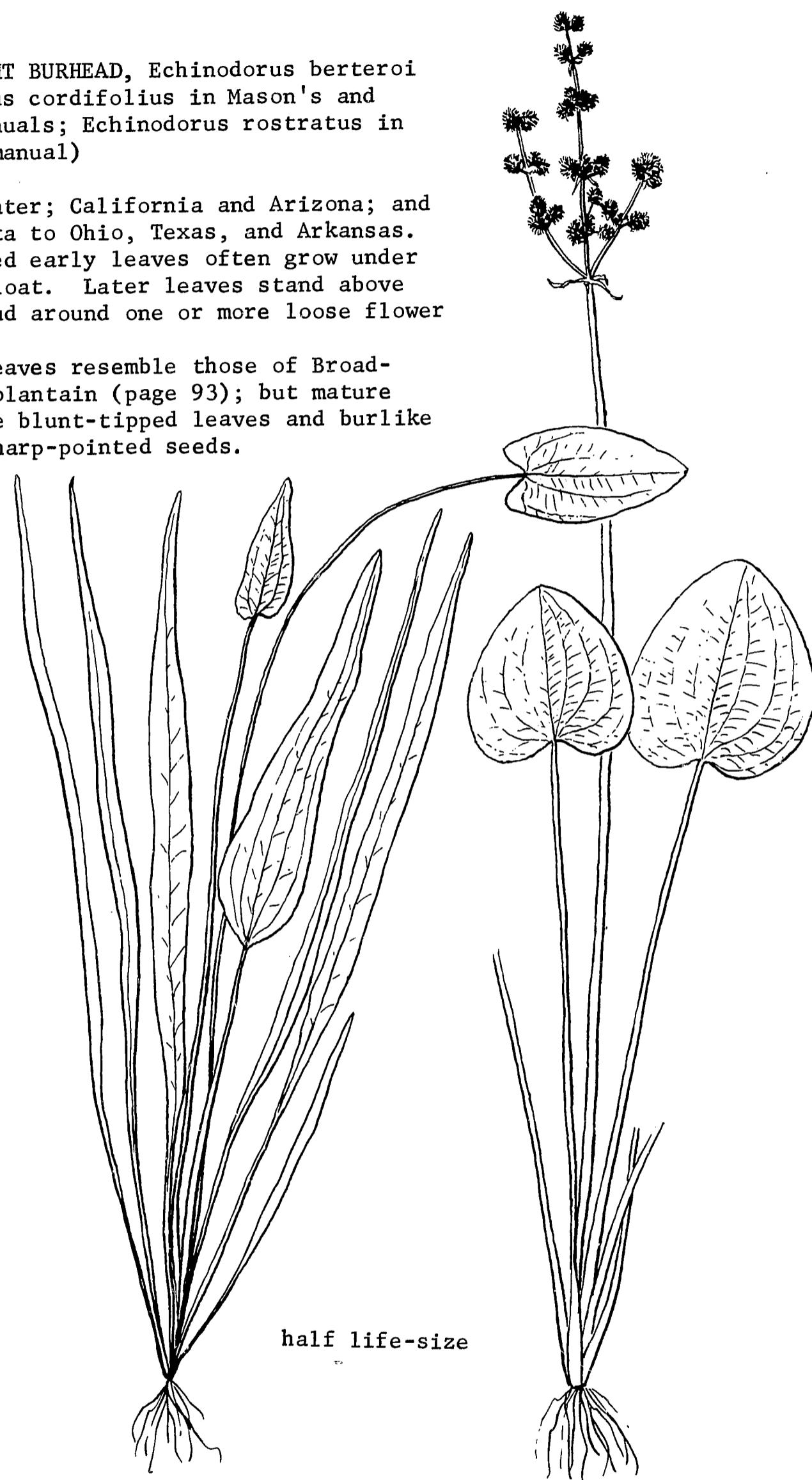
Grayish-green leaves which are as much as 2 feet across float or stand above water. When standing, they often look like partly-wrongside-out umbrellas. The pale-yellow fragrant flowers are as much as 10 inches across. The acornlike seeds are in individual pits in a flat-topped receptacle. When not quite ripe, they taste like chestnuts.

UPRIGHT BURHEAD, *Echinodorus berteroii*
(*Echinodorus cordifolius* in Mason's and
Small's manuals; *Echinodorus rostratus* in
Fernald's manual)

Fresh water; California and Arizona; and
South Dakota to Ohio, Texas, and Arkansas.

Clustered early leaves often grow under
water or float. Later leaves stand above
water or mud around one or more loose flower
heads.

Early leaves resemble those of Broad-
leaf Waterplantain (page 93); but mature
plants have blunt-tipped leaves and burlike
balls of sharp-pointed seeds.



LONGLEAF MUDPLANTAIN,
Heteranthera limosa

Fresh water; Colorado
to Minnesota, Arizona,
Louisiana, and Kentucky.

Leaves are under water,
floating, or out of water.
Flowers are blue or white.



half
life-size

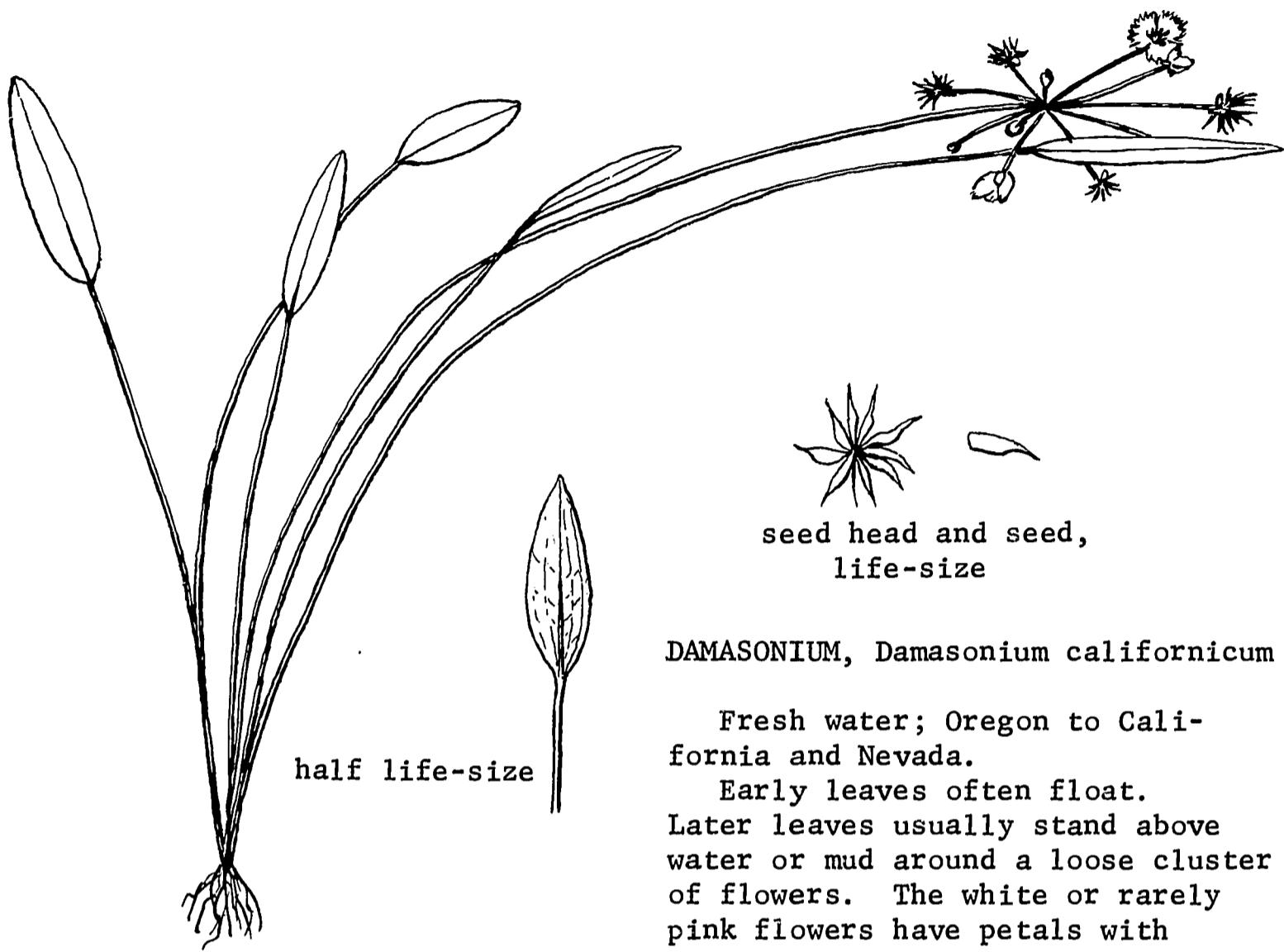
GOLDENCLUB, *Orontium aquaticum*

Fresh water, inland and
coastal; Iowa to Massachusetts,
Louisiana, and Florida.

Leaves float or grow out
of water. Their upperside has
a satiny sheen; underside is
whitish and has many lengthwise-
running veins. Flower spike is
yellow; the thick upper part of
its stalk is white.



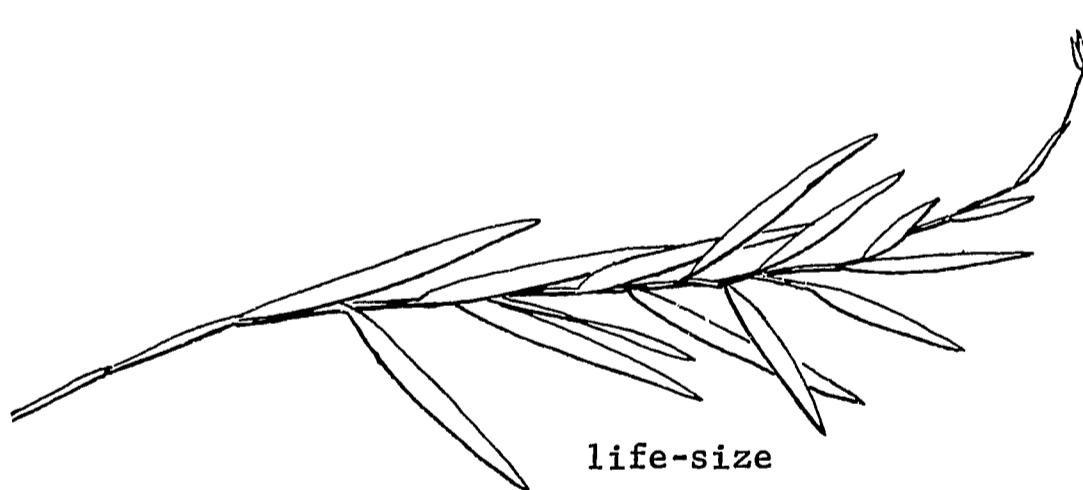
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life-size



DAMASONIUM, *Damasonium californicum*

Fresh water; Oregon to California and Nevada.

Early leaves often float. Later leaves usually stand above water or mud around a loose cluster of flowers. The white or rarely pink flowers have petals with toothed edges.

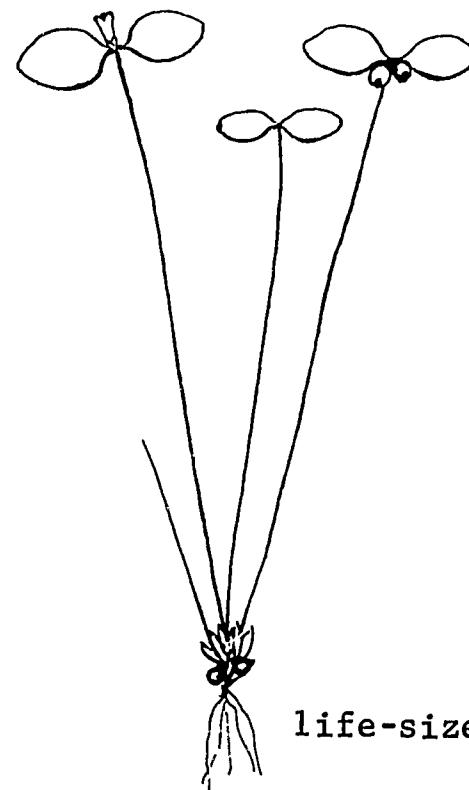


WATERGRASS, *Hydrochloa carolinensis*

Fresh water; North Carolina to Louisiana.

Leaves usually float in patches out from shore. Flowers are unlike those of any other plant.

Resembles a few other kinds of small-leaved grasses which are ordinarily out of water, but when temporarily flooded may be under water.



life-size

AMPHIANTHUS, *Amphianthus pusillus*

In depressions in granite which contain water in the spring; Alabama and Georgia.

Has a cluster of tiny leaves and flowers at the base of each plant, and a pair of larger floating leaves and a flower or two at the end of each stem.



half
life-size

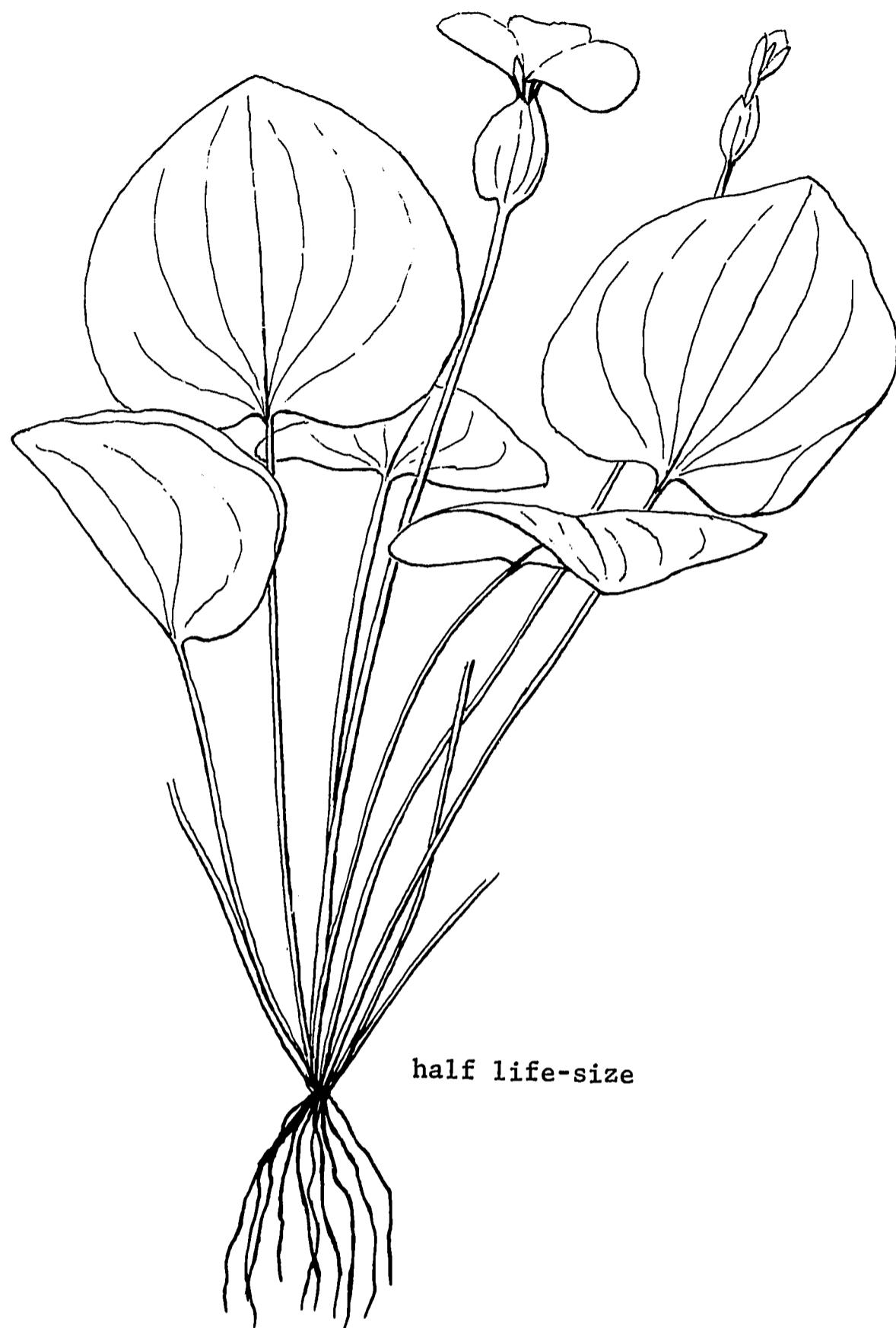


two times
life-size

SALVINIA, *Salvinia rotundifolia*

A native of tropical America which has run wild in fresh water in Georgia and Florida.

The entire plant floats, with its roots dangling in the water. Leaves are concave on the top, and have coarse hairs standing up in concentric rows.



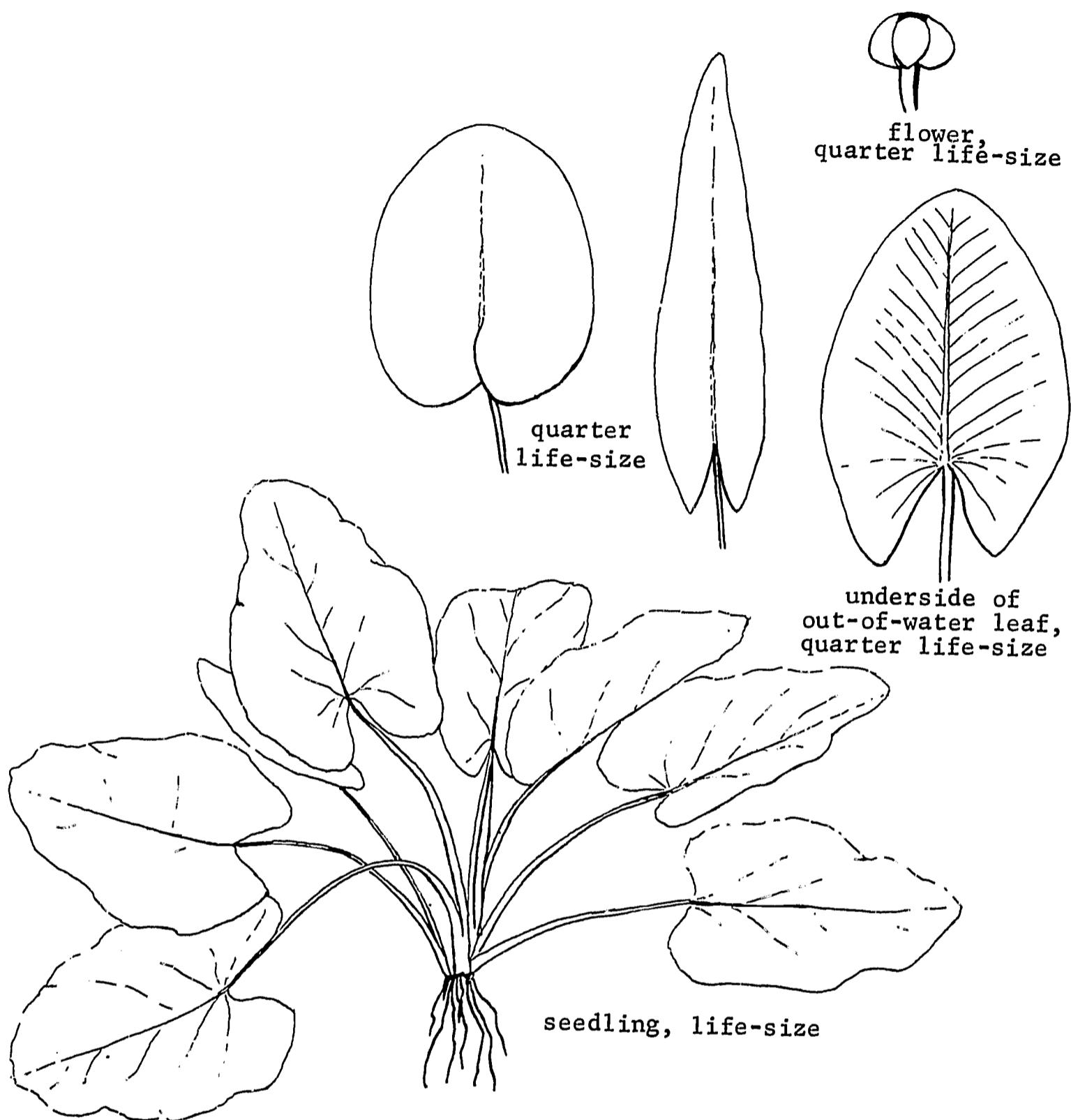
half life-size

OTTELIA, *Ottelia alismoides*

A native of southeastern Asia and of Australia which has run wild in fresh water in southwestern Louisiana.

Leaves are under water or floating. Flowers are white or pinkish.

Group 10. PLANTS WITH LANCE-SHAPED TO ROUND FLOATING LEAVES WHICH ARE DEEPLY NOTCHED AT THE BASE; A FEW KINDS ALSO GROWING PARTLY OUT OF WATER grow in fresh inland water and in fresh to slightly brackish coastal water. The leaves of some kinds are on flexible, upright to horizontal stems; others have leaves coming up from rootstocks. Most kinds have showy flowers: white, yellow, or bluish.



SPATTERDOCK, *Nuphar luteum*
 (all *Nuphar* in Fernald's and Mason's manuals; all *Nymphaea* in Small's manual)

Fresh water, inland and coastal; Alaska to Newfoundland, California, and Florida.

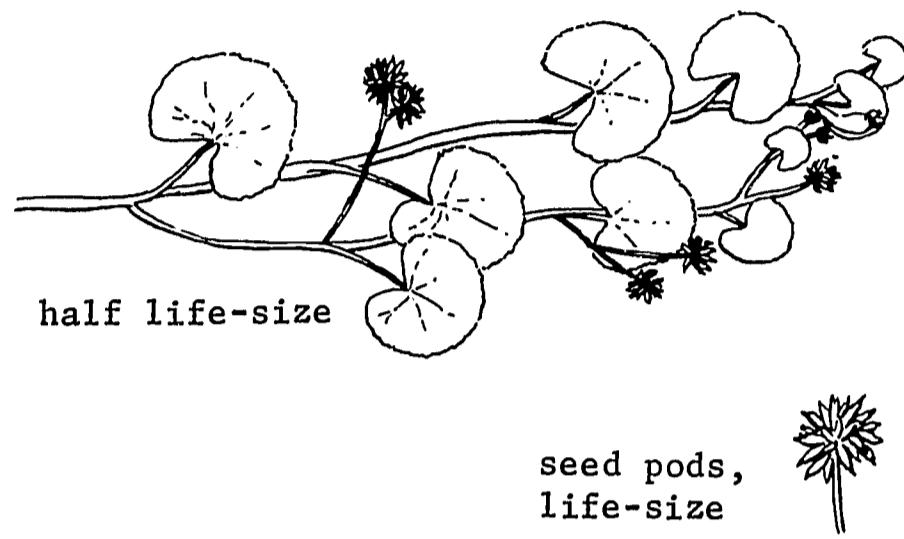
Leaves of mature plants roundish to lance-shaped, long-stalked; floating or standing above water (the latter form common along the coast from New York to Virginia). Flowers greenish outside and yellowish to reddish inside.

Leaves of seedlings flimsy and clustered under water. Seedlings resemble those of White Waterlily (page 105), with which they often grow; but Spatterdock leaves have blunter tips and a midvein with several veins on each side.

FLOATING CALTHA,
Caltha natans

Fresh water;
Alaska to North-
west Territories,
Alberta, and
Wisconsin.

Flowers white
or pinkish.



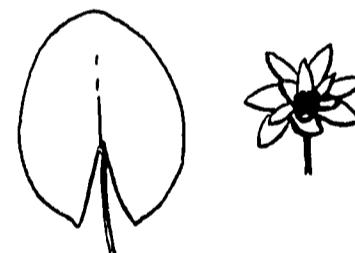
half life-size

seed pods,
life-size

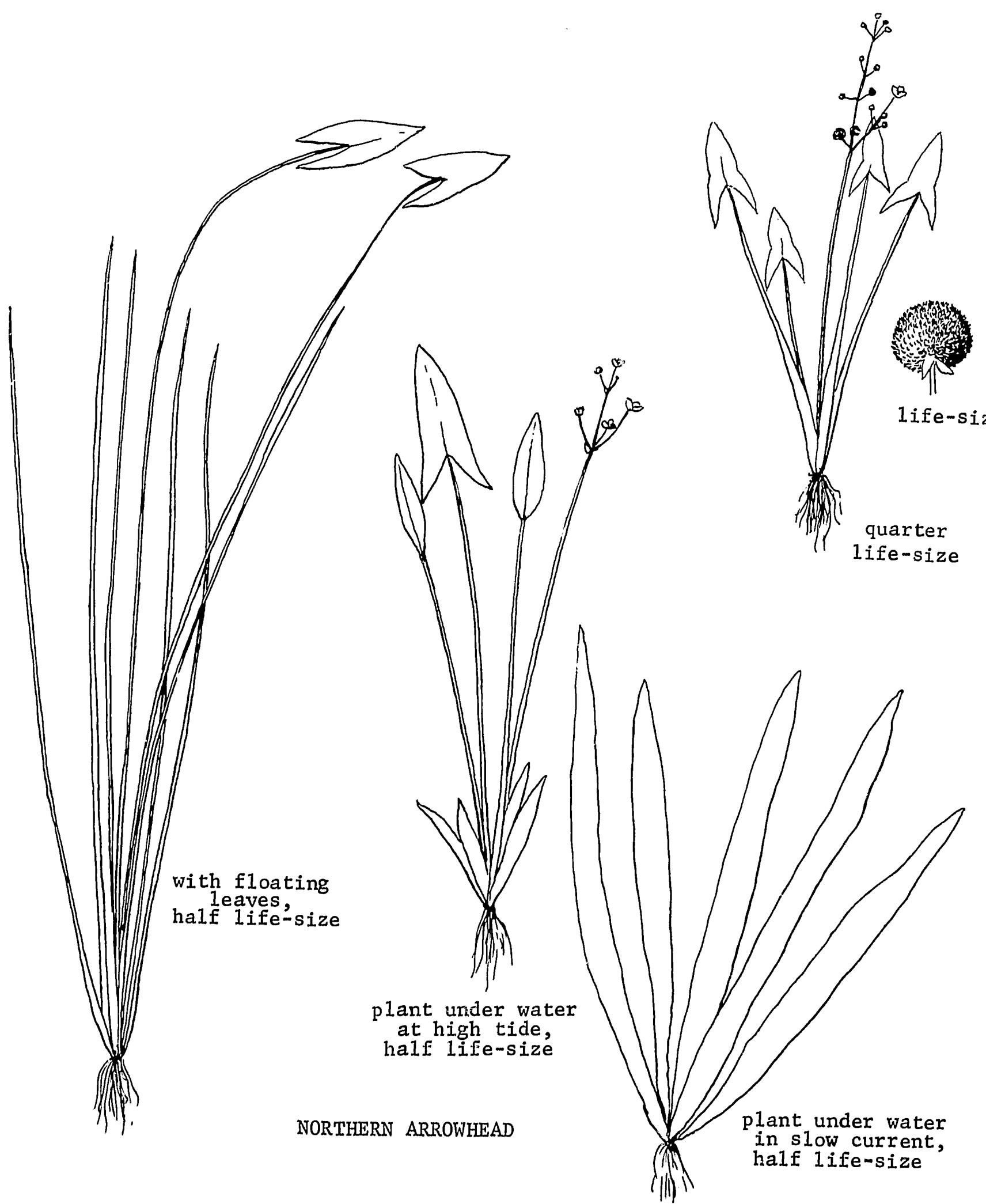
NORTHERN WATERLILY,
Nymphaea tetragona

Fresh water;
Alaska to Quebec,
Washington, Minne-
sota, and Maine.

Leaves of mature
plants longer than
wide. Flowers
white.



quarter life-size

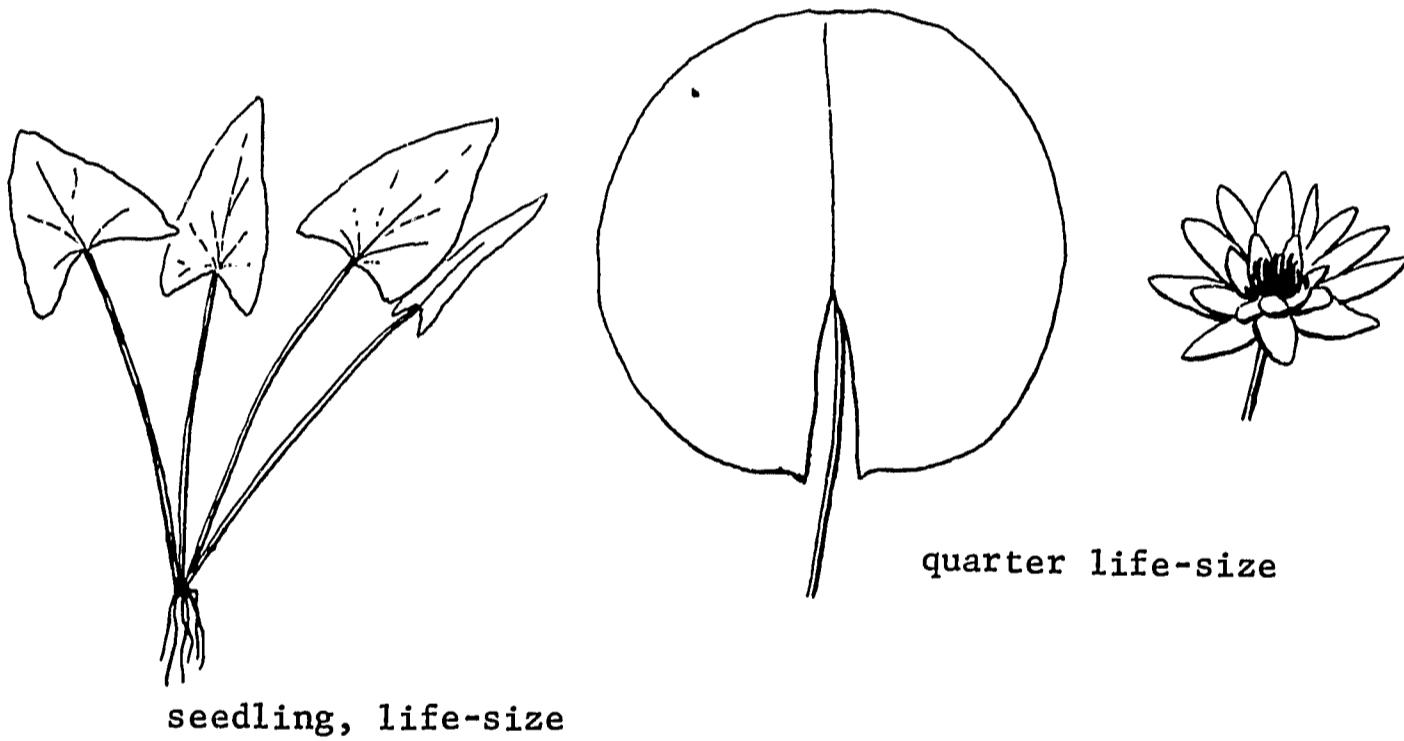


NORTHERN ARROWHEAD, *Sagittaria cuneata*

Fresh water; Alaska to Quebec, California, Texas, and Connecticut.

Sometimes has long-stalked, arrowhead-shaped floating leaves; but mature plants usually have their leaves and loose clusters of 3-petaled white flowers partly or entirely out of water. The lower flowers produce balls of tight-packed, flattish seeds.

Young plants are clumps of short and stiff to long and ribbonlike underwater leaves which cannot surely be told from some of the Arrowheads described and pictured on pages 18-20. When the leaves are ribbonlike, they can be told from the similar plants of Wildcelery, Burreeds, or Wildrice by holding a piece of leaf to the light and comparing it with the piece-of-leaf picture of Water Arrowhead on page 21 and the pictures on pages 6, 7, and 10.

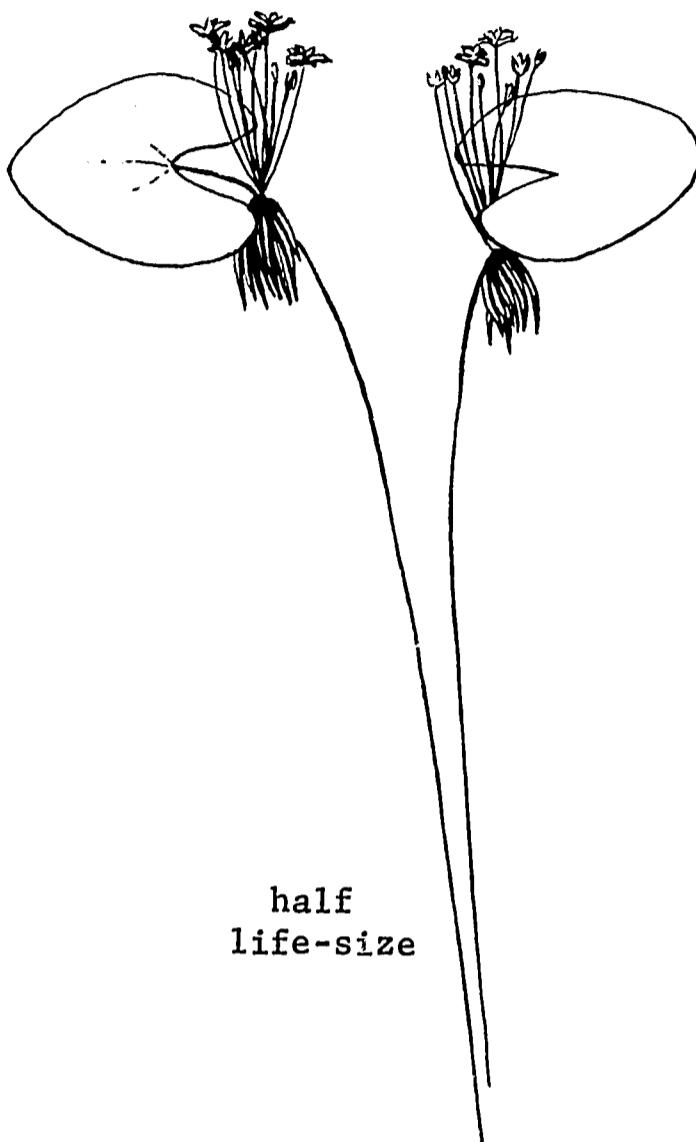


WHITE WATERLILY, *Nymphaea odorata*
(*Nymphaea tuberosa*; *Castalia lekophylla*, *minor*, and *odorata*)

Fresh water; Manitoba to Newfoundland, Texas, and Florida.

Leaves of mature plants firm and usually floating. Leaves of seedlings flimsy and clustered under water. Flowers white or rarely pink.

Seedlings of all the Waterlilies resemble each other; but usually only one kind grows in a locality. White Waterlily seedlings resemble Spatterdock seedlings (page 102), with which they often grow; but Waterlily leaves have sharper tips, and most of the veins radiate from near the base.



LITTLE FLOATINGHEART,
Nymphoides cordatum
(*Nymphoides lacunosum*)

Fresh water; Ontario to Newfoundland, Louisiana, and Florida.

A cluster of white flowers reaches just out of water; and a cluster of short, thick roots dangles from the stalk just under a leaf.

Resembles Big Floating-heart (page 109); but the smaller leaves are a little longer than wide; and they are often purplish-red underneath, but not covered with close-packed dots between light-colored veins.

EUROPEAN FROGBIT, *Hydrocharis morsus-ranae*

Not pictured.

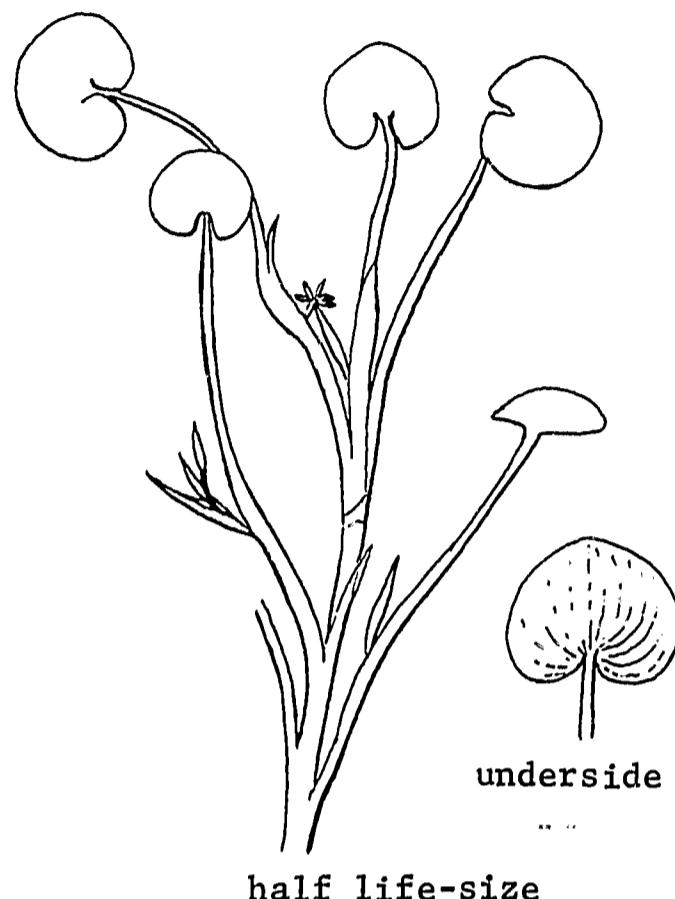
Has escaped from cultivation at Ottawa, Ontario; and since 1932 has spread several miles down the Ottawa River and been found near Montreal, Quebec.

The leaves resemble those of the floating form of American Frogbit (page 108); but they have almost no central sponginess. Three-petaled white flowers stand singly a little above the leaves. They are about 3/4 inch across and are half to two-thirds the width of a leaf.

ROUNDLEAF MUDPLANTAIN,
Heteranthera reniformis

Fresh water, inland
and coastal; Kansas to
Connecticut, Texas,
and Florida.

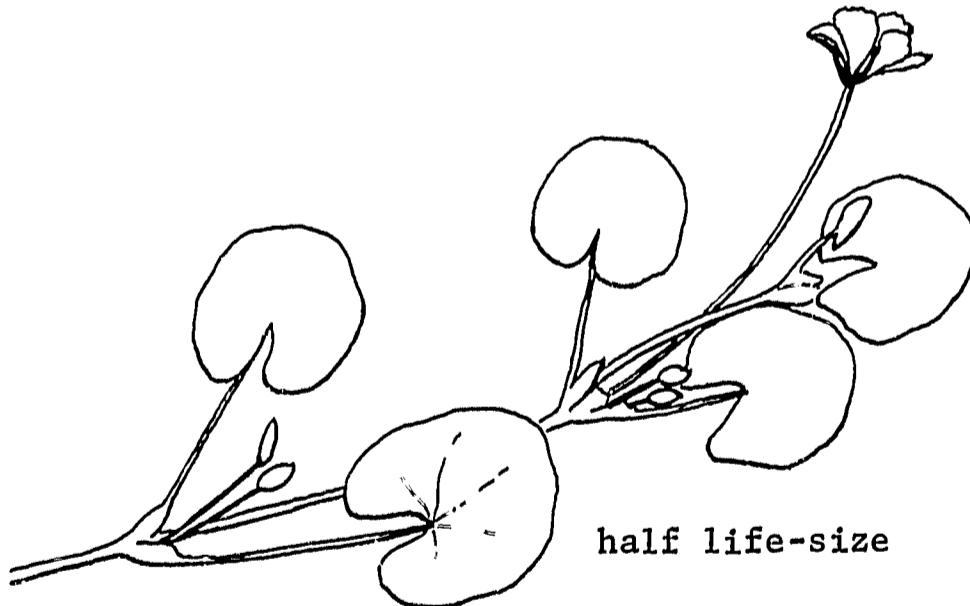
Leaves under water,
floating, or out of
water. Flowers white
or bluish.

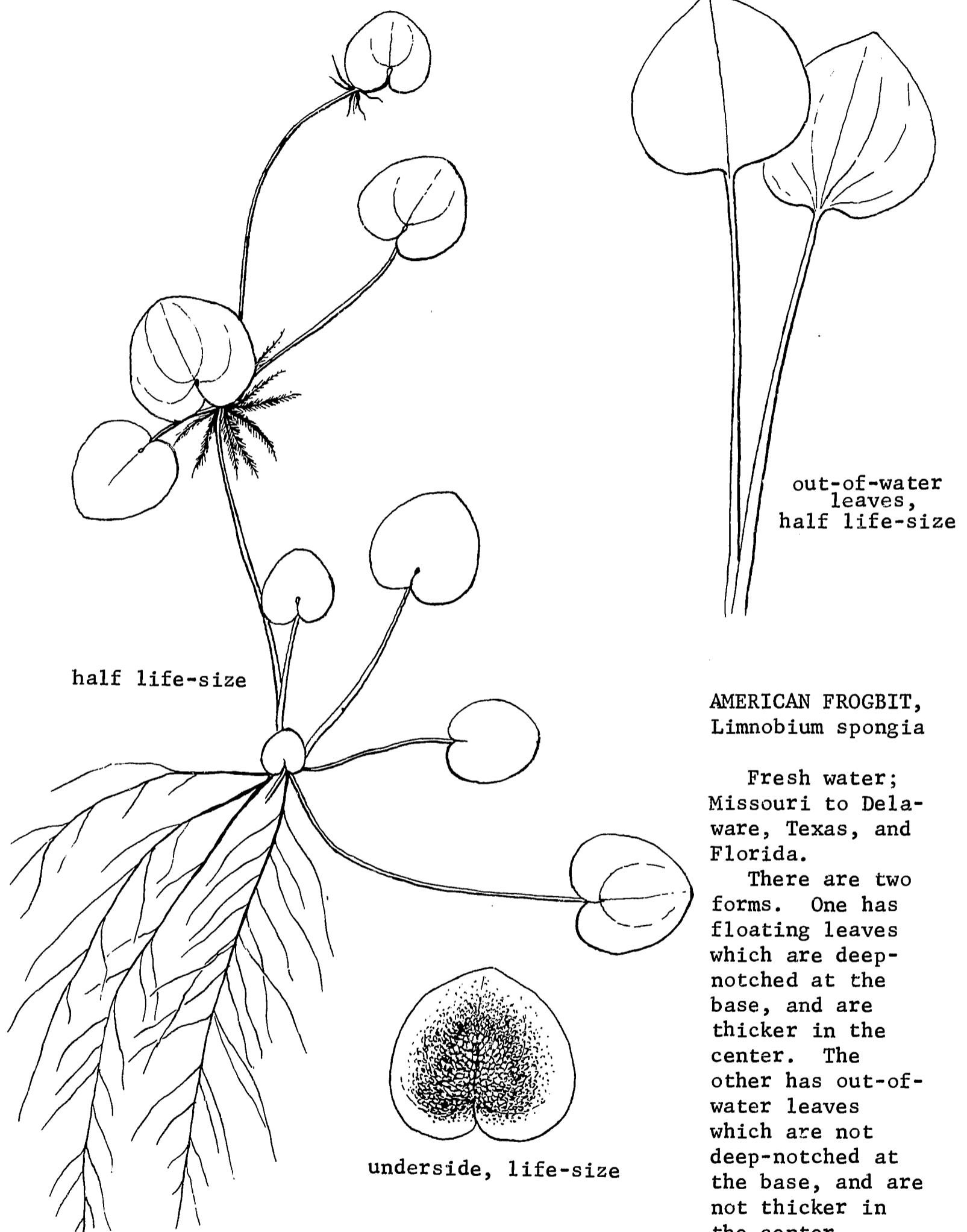


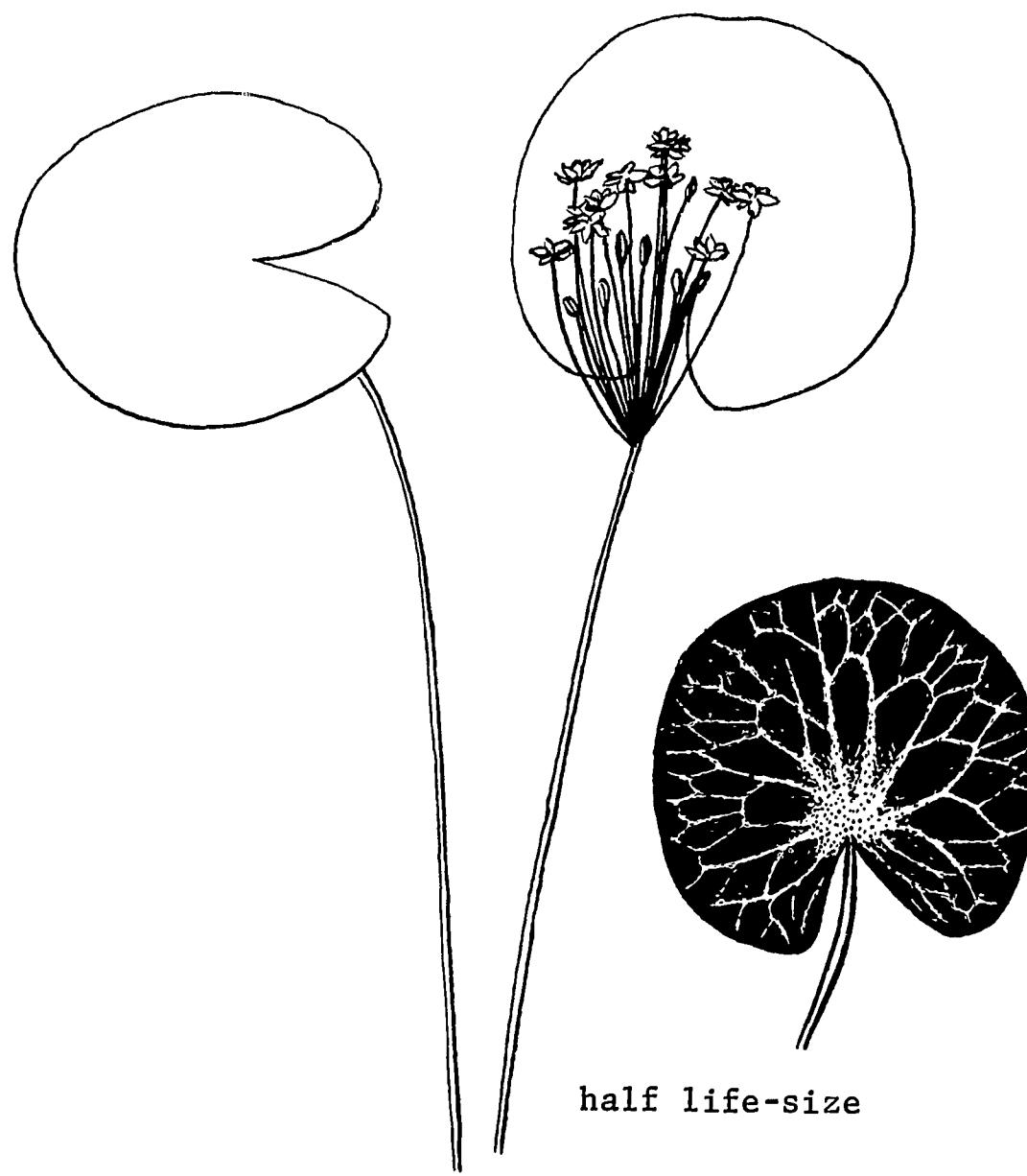
half life-size

YELLOW FLOATINGHEART,
Nymphoides peltatum

Fresh water, in-
land and rarely
coastal; a native of
Europe which has run
wild in a few local-
ties in Washington,
New York, New Jersey,
Missouri, Oklahoma,
and Arkansas.





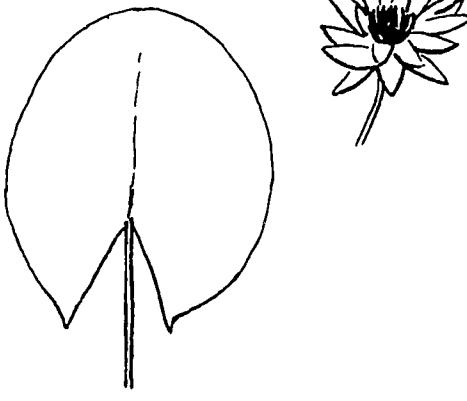


BIG FLOATINGHEART, *Nymphoides aquaticum*

Fresh water; New Jersey to Texas.

A cluster of white flowers reaches just out of water; and rarely a cluster of short, thick roots dangles from the stalk just under a leaf.

Resembles Little Floatingheart (page 106); but the bigger leaves are nearly round, and they are usually purplish-red with close-packed dots underneath, except along the light-colored veins.

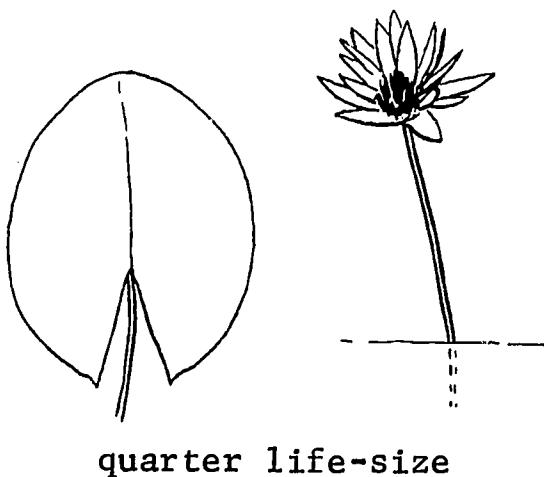


quarter life-size

BANANA WATERLILY,
Nymphaea mexicana
(*Castalia flava*)

Fresh inland water and
fresh to slightly brackish
coastal water; North Caro-
lina to Texas.

Flowers yellow. Clus-
ters of "bananas", an inch
or two long, develop late
in the year at the end of
slender rootstocks.



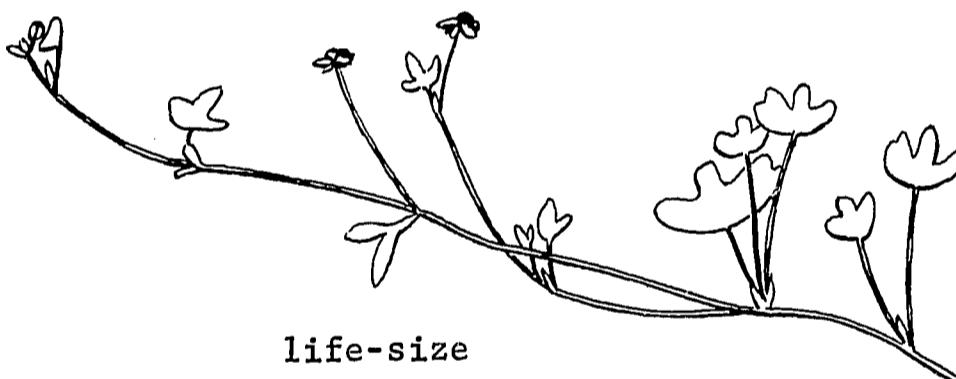
quarter life-size

BLUE WATERLILY,
Nymphaea elegans
(*Castalia elegans*)

Fresh water; southern
Texas (mainly), Louisiana,
and Florida.

Bluish or pale-violet
flowers stand several
inches above the water.

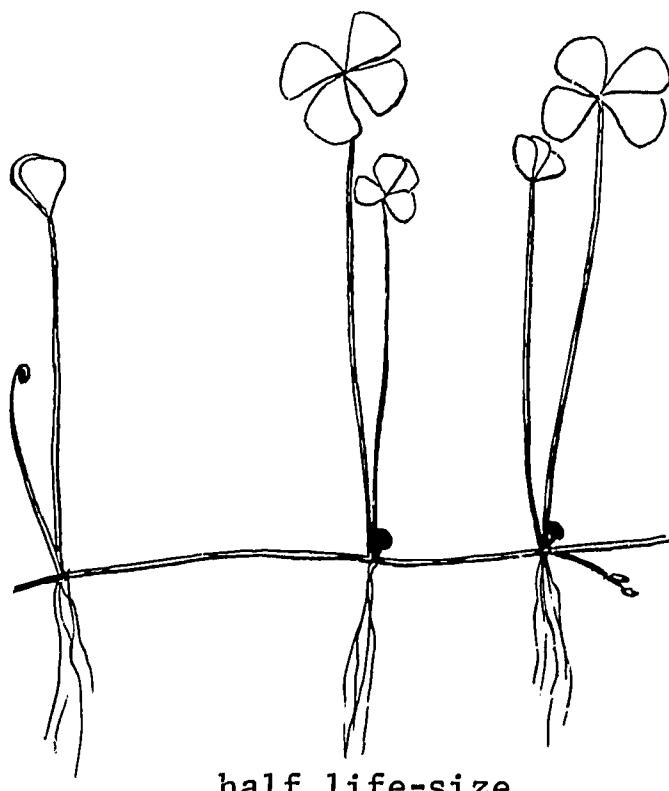
Group 11. PLANTS WITH COARSE-TOOTHEO, LOBED, OR DIVIDED FLOATING LEAVES; SOME KINDS ALSO GROWING PARTLY OUT OF WATER grow in fresh inland water and rarely in fresh coastal water. The leaves of Marsileas come up from rootstocks. Those of the other plants are on flexible, upright to horizontal stems.



ARCTIC BUTTERCUP, *Ranunculus hyperboreus*

Fresh inland water and fresh to brackish coastal water; Alaska to Greenland, Montana, and Newfoundland.

Leaves floating or growing partly to entirely out of water. Flowers yellow.



MARSILEAS, *Marsilea*

Fresh water; British Columbia to Massachusetts, California, and Louisiana (but commonest in the West).

Leaves are composed of four leaflets. They float, stand above water, or grow where there is no water.

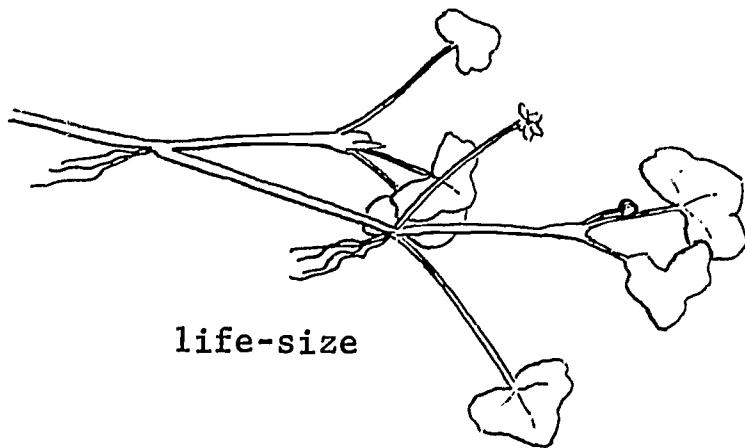
The five kinds known in Canada and the United States are described in Fernald's and Mason's manuals and in John Kunkel Small's "Flora of the Southeastern United States" (1913) as *Marsilea macropoda*, *mucronata*, *quadrifolia*, *tenuifolia*, and *uncinata*. *Mucronata*, by far the commonest, grows in southwestern Canada and the western half of the United States. *Quadrifolia*, a native of Europe, has run wild in a few places in the northeastern quarter of the United States. The others have been found only in Texas and neighboring states.

Tenuifolia has very narrow leaflets. The others have wide leaflets, similar to those pictured of *mucronata*. They can be told apart when they are bearing little bean-shaped sporocarps close to the base of leaf stalks.

IVYLEAF BUTTERCUP,
Ranunculus hederaceus

This native of Europe has been found in fresh water in a few localities from Newfoundland to South Carolina.

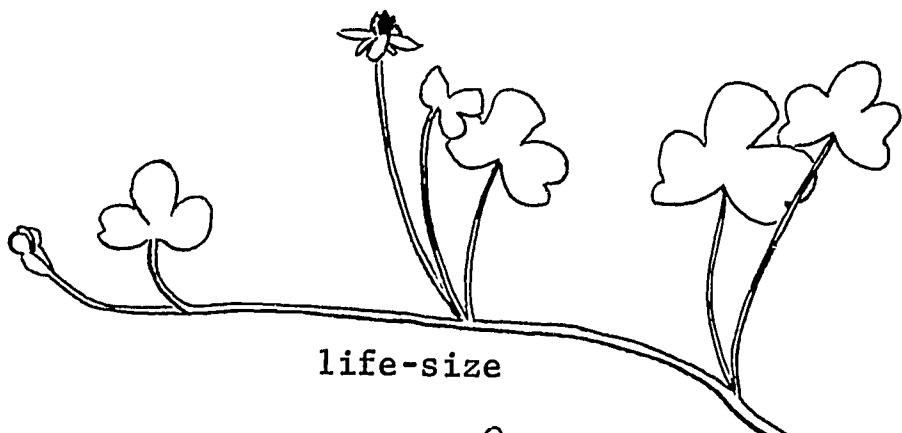
Leaves floating or growing partly or entirely out of water. Flowers white.



FLOATING BUTTERCUP,
Ranunculus natans

Fresh water; Alberta to Colorado.

Leaves floating or growing partly or entirely out of water. Flowers yellow.

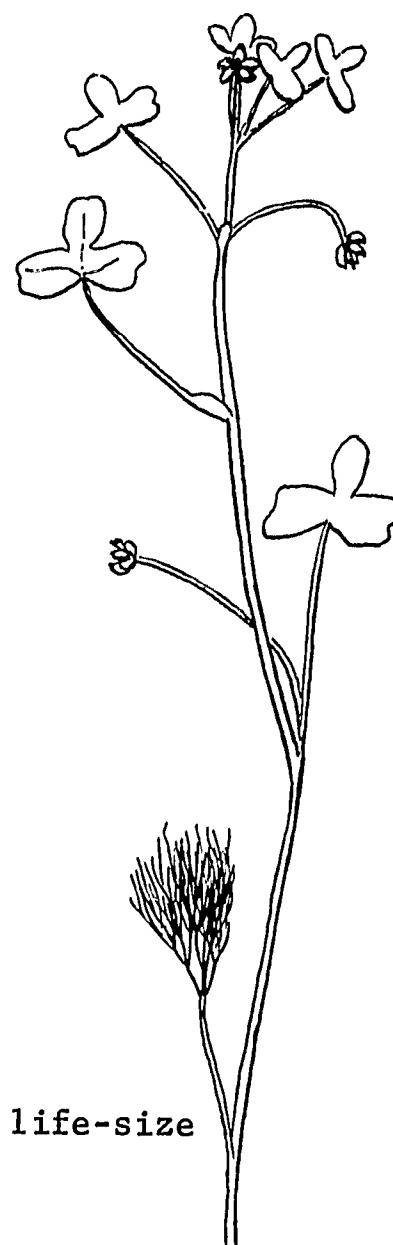


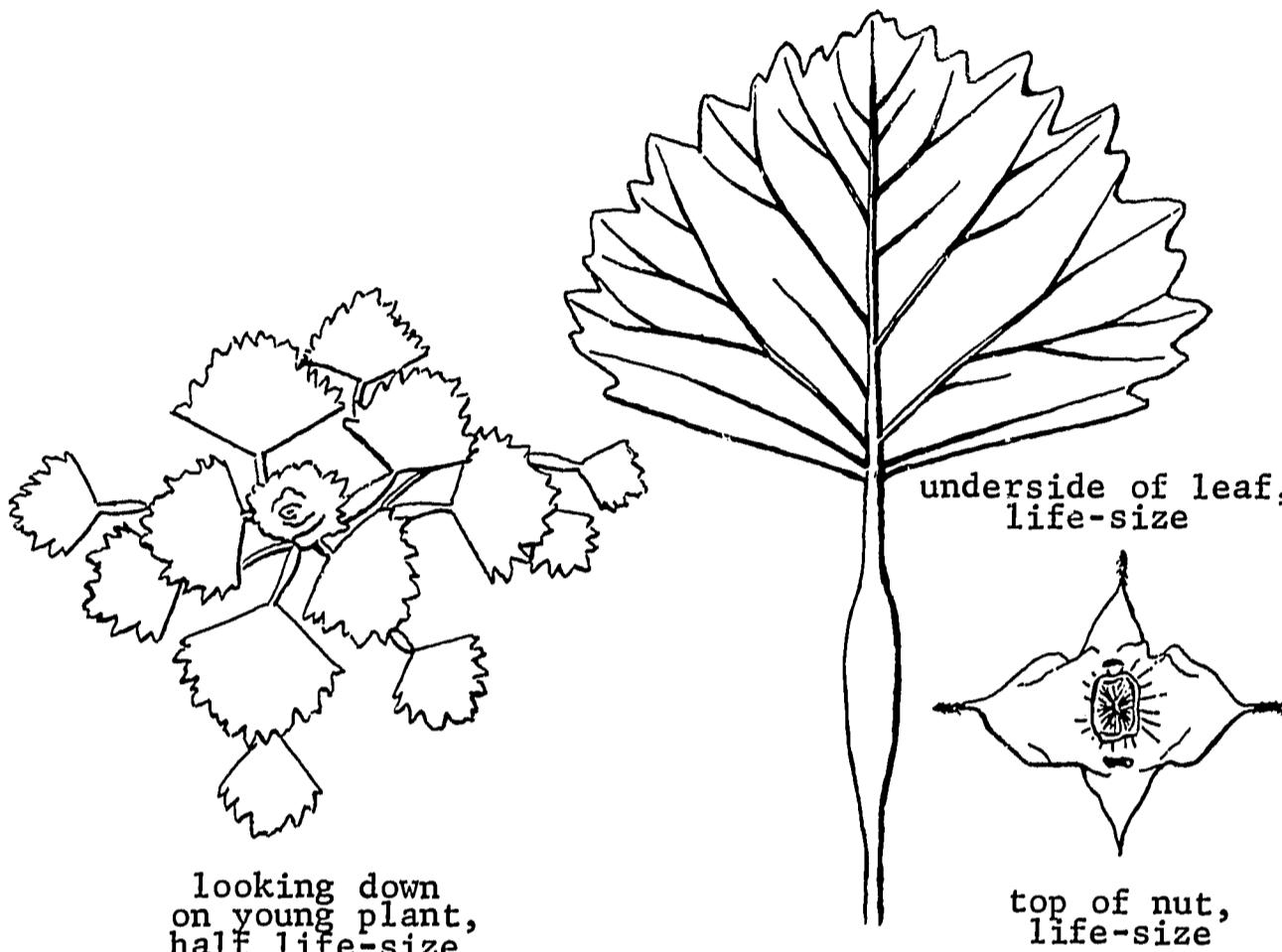
LOBB BUTTERCUP,
Ranunculus lobbii

In pools which contain water in the spring; British Columbia to California.

Most of the leaves float. Sometimes there are fine-forked under-water leaves. Flowers white. Seed balls with no more than 6 seeds apiece.

Resembles White Water Buttercup (page 53); but has mainly floating leaves and fewer seeds in a ball.





WATERCHESTNUT, *Trapa natans*

Beginning in the 1930's, this native of Eurasia became so abundant in fresh water in a few coastal and inland localities from New York to Massachusetts and Virginia that it spoiled boating, fishing, and swimming, and crowded out duck-food plants. In some places it has been greatly reduced by cutting and chemicals.

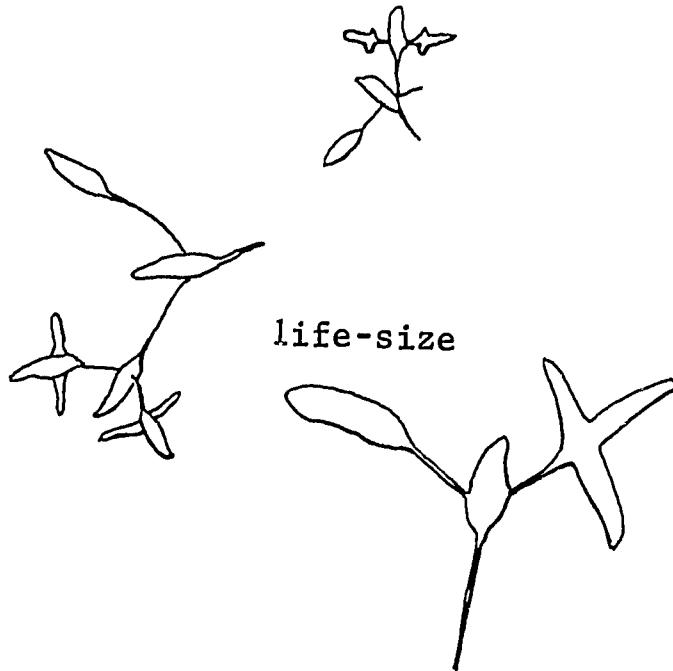
Rosettes of floating leaves are shiny on the upper side, dull and fine-hairy underneath. Small white flowers, on short stalks among the leaves, produce sharp-horned, inch-across nuts which, fallen to the bottom or drifted on a shore, stab bare feet.

Group 12. LITTLE, FREE-FLOATING PLANTS grow in sheltered fresh water, often in the shade of trees, shrubs, and marsh plants. Reproduction is mainly by offshoots from growing plants.

STAR DUCKWEED, *Lemna trisulca*

Fresh water; Alaska to Quebec, California, and Georgia (but rare in the southeastern states).

Half-floats under the surface of water which is sheltered from wind and which contains much nitrogenous matter; often under a blanket of Duckweeds and Watermeals. Dull-green. New plants grow from old ones; and several individuals are often attached to each other.

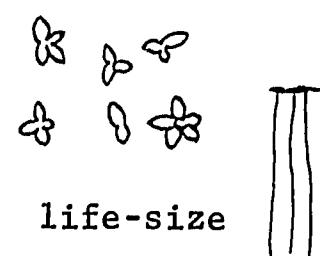


LITTLE DUCKWEEDS, *Lemna*
(except *Lemna trisulca*, above)

Fresh water; Alaska to Quebec, California, and Florida.

A green blanket on water which is sheltered from wind and which contains much nitrogenous matter; often mixed with Big Duckweeds and Watermeals. New plants grow from old ones; and a few individuals are often attached to each other. One root dangles in the water from each plant.

The five kinds known in Canada and the United States cannot surely be told apart without a hand lens or microscope, and then only when they have seeds. They are *Lemna gibba*, *minima*, *minor*, *perpusilla* (*trinervis*), and *valdiviana* (*cyclostasa*).

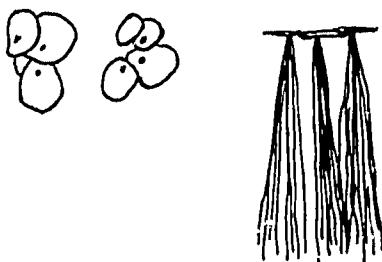


BIG DUCKWEEDS, *Spirodela*

Fresh water; British Columbia to Nova Scotia, California, and Florida.

A green blanket on water which is sheltered from wind and which contains much nitrogenous matter; often mixed with Little Duckweeds and Watermeals. Green above, often reddish underneath. New plants grow from old ones; and a few individuals are often attached to each other. A cluster of roots dangles in the water from each plant.

Two kinds are known in Canada and the United States. *Spirodela polyrhiza* has the range given above, and is the commonest. Each plant usually has 6 or more roots. *Spirodela oligorhiza* (not pictured) is a native of southeastern Asia and Australia which, since the 1930's, has been found wild in California; and from Missouri to Maryland, Louisiana, and Florida. It is about the same size and shape as the Little Duckweeds (page 115), and each plant usually has only 2 or 3 roots.



Spirodela polyrhiza,
life-size



two times
life-size

WATERMEALS, *Wolffia*

Fresh water; Oregon, California, and Utah; and Nebraska to Quebec, Texas, and Florida.

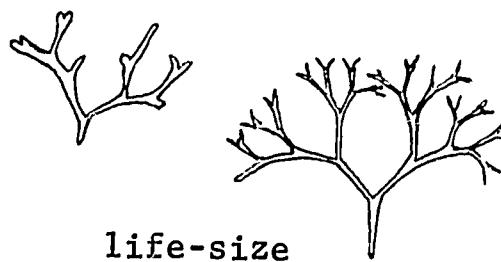
A green blanket on water which is sheltered from wind and which contains much nitrogenous matter; often mixed with Duckweeds. Individual plants are the size of a small pinhead. New plants grow from old ones; and two individuals are often attached to each other.

The five kinds known in Canada and the United States cannot surely be told apart without a hand lens or microscope. They are *Wolffia arrhiza*, *columbiana* (*Bruneria columbiana*), *cylindracea*, *papulifera*, and *punctata* (*Bruneria punctata*). The pictures show differences which can sometimes be seen with the naked eye: the round type is light-green all over; the oval type floats on the water like a boat, and is darker green on the top than it is underneath.

RICCIA, *Riccia fluitans*

Fresh water, British Columbia to Maine, California, and Florida.

Half-floats under the surface of water which is sheltered from wind and which contains much nitrogenous matter; often under a blanket of Duckweeds.

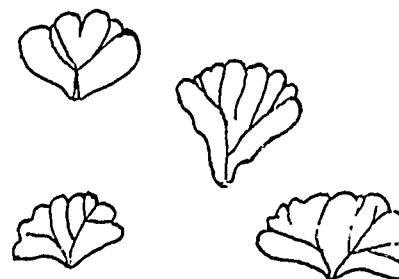


life-size

RICCIOCARPUS, *Ricciocarpus natans*

Fresh water, British Columbia to Maine, California, and Florida.

On water which is sheltered from wind and which contains much nitrogenous matter; often mixed with Duckweeds. Underside covered with dark-reddish, dangling, rootlike scales.



life-size

WATER-VELVETS, *Azolla*

Fresh water; British Columbia to Idaho, California, and New Mexico; and Minnesota to New Hampshire, Texas, and Florida.

A dull-green to reddish blanket on water which is sheltered from wind and which contains much nitrogenous matter.

The three kinds known in Canada and the United States cannot surely be told apart without a hand lens or microscope. They are *Azolla caroliniana*, *filiculoides*, and *mexicana*.



two times
life-size

EASTERN WOLFFIELLA,
Wolffielia floridana

Fresh water; Illinois to Massachusetts, Texas, and Florida (but commonest in the southeastern states).

Half-floats under the surface of water which is sheltered from wind and which contains much nitrogenous matter; often under a blanket of Duckweeds and Watermeals. Looks like fine-slivered pieces of grass.

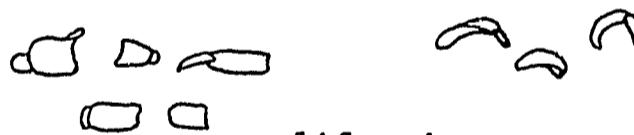


life-size

TONGUE WOLFFIELLA,
Wolffielia lingulata

Fresh water; California and Louisiana.

Half-floats under the surface of the water.



life-size

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extra cost) to a desk telephone with headset jack, or to 4A key equipment. The special use of a Touch-Tone model Trimline set is shown in Fig. 37.

Dials.

A Touch-Tone dial may be operated by a long mouthstick. Using one on a rotary dial is very difficult and should not be advised. Manual service may be necessary.

Testing the use of a mouthstick.

There may be one location on the patient's lap-board where he can exert the greatest force from his mouthstick. This will be the position in which to place the appropriate switch for his test (headset lever switch of desk telephone with headset jack, or line button of 6-button one, key of 4A key equipment, buttons of Speakerphone transmitter, modified if necessary).

After he has demonstrated his use of the switch, it should be replaced by a Touch-Tone dial (where available) for him to test. When he can use both switch and dial at this one position, test to see whether he can use them when they are in other positions nearby, found by an analysis of his use of space. Be sure that these locations do not interfere with other activities he performs in this area, e.g., reading a book. Continue experimenting until locations are found for all the equipment. (Do not exclude special mountings for a dial or switch. See "Reclining-Back Wheelchairs," p.126).

When Touch-Tone service is not available, the patient may attempt to use a rotary dial if it can be mounted very near to his head, so that the mouthstick is no longer than 8 to 10 inches. A short "ball" dialer attachment should be placed on the end of the mouthstick. Caution should be observed that it does not put too great a strain on his teeth. The patient may find that he cannot use a rotary dial and may request manual service (if available).

Remarks: The person with motion only at his neck and head will always need assistance for his care and this may include the necessity of having the telephone equipment placed in position for his use. While complete independence in using the telephone may be desirable, its cost may be a deterrent to one who uses the telephone infrequently.

RHEUMATOID ARTHRITIS

Equipment for Conversation

Handsets.

The person who can use a handset may prefer either the standard or the Wear-it-or-Hold-it handset. Both should be tested.

Speakerphone.

Excellent. Enlarged tops to the buttons may be helpful.

Handset-holding devices.

Either a gooseneck arm or extension arm may be suitable. When the inability to use a handset is due to loss of joint range of motion the gooseneck arm will be preferred. A shoulder rest is rarely suitable.

Headsets.

The choice will depend upon whether the person wishes to use the lightweight headset on eyeglass frames or the operator's headset on a headband. The person who has a pushing-stick may use it to adjust the headband (Fig. 38).

Switches.

The type of switch selected may depend more upon the person's ability to reach it than upon its method of operation, although, generally, lever switches will be easier to manage than stiff push-buttons.

Dials.

The Touch-Tone dial may be advantageous, but occasionally the act of pressing buttons is painful and the rotary dial may be preferred. A "ball" dialer will be helpful and is recommended for use by a patient whose fingers have been affected by the disease process.

SPINAL CORD QUADRIPLEGIA

Quadriplegia following a spinal cord lesion at a specific level will result in a loss of function of muscles innervated below the lesion and can produce a predictable pattern of residual function. When the lesion is not complete, the residual function may be different in either arm. The tabulation that follows on p. 123A, of the use of the telephone by the spinal cord quadriplegic, is listed according to the arm with the highest level of residual muscle function. *The levels in the table do not imply that the muscle strength is capable of performing against resistance.* A Poor muscle may be useful for joint stabilization.

The person with function greater than for group F is not listed, as he will have adequate use of most equipment. The spinal cord quadriplegic of group A who does not use balanced forearm orthoses or their equivalent should be treated as a "person without arm function," p. 115.

The following table is intended as a guide and should not be interpreted rigidly. Persons within each group may wish to test the equipment listed for the next higher or next lower group.

Equipment is tested in the normal order, i.e., equipment for conversation, switches, and dials. The choice will be influenced by the general factors outlined previously on pp. 58-66.

8.

The Final Choice of Telephone

As the testing of the patient proceeds, it should be accompanied by discussion of the circumstances in which he will use a telephone. These general factors were described fully pp. 58-66, and the point to be covered with the patient are summarized below.

At home.

The evaluator should consider the layout of the house, to discover in which rooms and at what times the patient will use the telephone; the family routine, to see how these movements and the patient's needs through the day correspond with other members of the family. Could one telephone be moved from room to room or is more than one telephone desirable? Does the patient use the telephone sufficiently to warrant the expense of premium equipment? Will he be alone occasionally, can the telephone be placed where he can reach and operate it, and, for an incoming call, in sufficient time?

At place of work.

The evaluator should consider the location of the telephone on the patient's working area for economy of effort and space; the use by others of the same telephone; the need for private conversation; the use of extension and hold buttons; the operation of other switches for a tape recorder, summoning a secretary or another staff member; the cooperation of the employer.

It is helpful to bear in mind that the evaluator evaluates the patient's function, decides which telephones are relevant to his needs, and provides opportunity for the patient to compare one with another. He assists the patient in analyzing the background factors involved and for some pieces of equipment shows the patient how to develop skill in their use. But the final choice of which telephone is to be installed must be made by the patient and his family, or his employer.

9. **Assistive Equipment and its Significance for Use of the Telephone**

WHEELCHAIRS

Wheelchair Arms

Desk arms on a wheelchair will allow the user to approach under any desk or table.

Straight arms usually have a height of 30" and will not fit under an average height desk or table. The wheelchair user who for this reason has difficulty reaching a telephone placed on an ordinary desk or table may require one of special design or a telephone shelf that will project toward him.

Footrests

If the footrests obstruct the disabled person's approach to a wall telephone, he may have to approach the telephone diagonally or parallel to it. When the patient also has a loss of arm function, using a telephone from this position may not be possible and he may need a suitable surface on which to place a desk telephone.

Lapboard

The person using a lapboard for convenience would not necessarily find that it would bar his approach to a telephone. He might use it on occasion as a place on which to rest the telephone.

A raised lapboard has two implications: either the user will not be able to approach under the average height table and may need a special shelf on which to place the telephone, or the loss of muscle function that necessitates use of this raised lap-

board can prevent the user from propelling his chair manually and reaching a telephone placed elsewhere than on top of the lapboard.

TYPES OF WHEELCHAIRS AND THE USE OF A TELEPHONE

"Standard" Wheelchairs

The term "standard wheelchair", as used in this text, refers to any wheelchair that may be propelled manually by the user.

Propelled by the User.

When the user has good trunk balance and adequate use of his arms, he may reach either to the front or over the sides of the wheelchair to a telephone placed on a table or wall. If he is unable to reach a wall telephone from a frontal approach, he should approach diagonally, so the arm he will use is on the side away from the telephone (see Fig. 41, p. 137). If this diagonal approach is not possible, one parallel to the wall may be effective. From these positions he can reach across his body to use the telephone. For the person with impaired arm function, using this opposite arm is usually necessary to permit grasping the handset and operating the dial.

The person unable to reach out from the chair may need a projecting shelf for the telephone, so that he can make a frontal approach to it.

The user who cannot propel his chair.

When the disabled person is unable to propel himself, it will be necessary for another person to place the telephone equipment in position for his use, probably on his lapboard. When he wishes to use a telephone in different rooms, wall jacks could be installed to allow its transfer.

Normally, 4A key equipment has to be located in one place due to the wall mounting of the equipment box. When it is more convenient for the disabled person to have this equipment in more than one location, the equipment box could be secured to a board and the other units placed on it. The board could then be brought to the disabled person as necessary.

When a Speakerphone is used and the patient would like to carry it with him, the transmitter unit can have a long cord (by special arrangement) to allow it to be placed on his lapboard.

When a call comes for the disabled person, it may not always be convenient for others to bring the telephone to him or to move him to its location. Taking a call over the regular telephone will require another person to hold the handset to the patient's ear when he is unable to do so. When his chair incorporates openings for a hook-on headrest, a specially constructed device for holding the handset may be inserted as needed (see p. 37).

The more severely disabled person may have to depend on others for his transfer from bed to wheelchair, and the time at which this is done may depend on the convenience of the family. In this case, it will be helpful to know when the patient will be in bed, when he will be in the chair, in which rooms he will be, and how these arrangements fit into the routine of the family. Information on the use of the telephone by the entire household will be helpful in planning the most appropriate telephone installation for them.

The severely disabled person's ability to use a telephone independently can provide greater freedom for him and for his family, by making it possible for him to be left alone in the house occasionally. The family would be able to call him while they were away, and he could place a call if any emergency arose. This may not be possible or desirable for all severely disabled persons, but in those cases where such independence is important to the patient and his family, every effort should be made to devise a suitable method.

Reclining Back Wheelchairs

The user of a reclining back wheelchair may wish to use a telephone only when sitting upright, or he may wish to use it both when sitting and reclining. Unless his use of the telephone is extensive enough to warrant two telephones, the unit chosen should be sufficiently versatile to be used in both positions.

When a handset mounted by the patient's ear is

considered suitable, or when a switch needs to be placed by the head of the person without arm function, the openings in the tubular frame of a reclining back wheelchair used for the hook-on headrest provide a convenient place for the insertion of handset-holding equipment (such as a gooseneck arm, see p. 37), or a mounting for a switch (see Fig. 33, p. 117). These openings cannot be used when the user reclines, however, since the headrest would then be placed in them. Nor can they be used when his neck is weak and he needs the constant support of the headrest. In these cases, securing the switch, or handset-holding arm, to the wheelchair by a clamp can be considered. A suitable one is the "standard chair bracket for overhead rod" normally used for the overhead rod of an arm suspension sling. A source for this is Jaeco Orthopedic Specialties, Box 616M, Route 5, Hot Springs, Arkansas 71919.

Either of these methods of attaching a handset-holding arm to the wheelchair will necessitate modifying the lower end of the arm.

Motorized Wheelchairs

The points already outlined for the very severely disabled person in a standard wheelchair or a reclining back wheelchair may be appropriate to the user of a motorized wheelchair, with one significant difference: the user is able to move himself to a telephone. Because he will be incapable of moving his arms over more than a small area, considerable ingenuity may be required to find a telephone that this disabled person is able to use independently.

A Speakerphone is an excellent choice, particularly when the patient has a desk under which he can drive and over which he can reach with his arms (see Figs. 3 and 4, pp. 63, 64). When he cannot reach the Speakerphone on a desk, a separate switch (e.g. 6017-type key), placed where it can be operated after propelling the chair toward it, would allow him to take incoming calls easily. Alternatively, the transmitter buttons may be operated by using a paddle-lever device when this provides a sufficient projection for the patient to reach. To make an outgoing call by dialing independently may be more difficult to arrange unless Touch-Tone calling is available. In such cases, locating a separately housed Touch-Tone dial in a projecting position may allow the patient to dial. This positioning would also apply to 4A key equipment, although providing for conversation would be more difficult than when using the Speakerphone. A gooseneck arm could be used for the handset, placed where the patient could drive up to it.

A special arrangement for the person who can move only his head and neck utilizes the Trimline set (Fig. 37, p. 121). The Touch-tone dial handset is mounted on a projecting rod and calls are connected and disconnected by microswitch.

ASSISTIVE EQUIPMENT FOR THE UPPER EXTREMITY

Balanced Forearm Orthosis

When muscle weakness about the elbow and shoulder prevents a disabled person from bringing his hand to his mouth, a balanced forearm orthosis (previous terminology—"feeder") may be employed. It is a balancing device which may be attached to the wheelchair and onto which the forearm is rested.

A balanced forearm orthosis (BFO) consists of an assembly of freely moveable parts, composed of rods and ball bearing joints, attached at one end to the wheelchair frame and at the other to a forearm trough. The connecting rods allow horizontal movement of the arm, and a pivot centered under the forearm trough allows the hand to move vertically. The balance of each component is delicately adjusted to utilize all the force the person is capable of exerting. Several types are in existence, Fig. 3, p. 63 illustrates one commonly used.

Whichever mechanism is used, a BFO operates by supporting and positioning the arm and employing the advantage of counterbalance. In this way, the effects of gravity and resistance on movement are reduced, and through redistributing the weight, a minimum of power can produce the desired movement. However, the delicately balanced system cannot accommodate more than a small amount of additional weight or force. Operations such as lifting a handset or using the hand to apply pressure may not be feasible.

Telephoning.

Frequently, the person who requires these orthoses cannot lift a standard handset, nor can he lift a Wear-it-or-Hold-it set completely up to his ear. However, he may be able to use the lighter-weight set when he can bring his head down to meet it.

Downward pressures may be more difficult to exert than horizontal pushing and pulling. Therefore, lever switches will be preferred to standard pushbuttons. The rotary dial may be easier for some people to use than the Touch-Tone dial.

A low height for telephone equipment may allow force to be exerted most effectively; thus a separately housed dial may be preferred (see Fig. 11, p. 87).

The person with a flail hand and wrist may wear an ADL long opponens orthosis or rest the palm of his hand on a support extending from underneath the forearm trough of the BFO. By means of a detachable spring-clip (see Fig. 20, p. 98), the orthosis or the support will receive attachments such as a pen, dialer, or typing stick. The typing stick may be used for moving levers or pressing buttons, or a dialing tool may be substituted for use with a rotary dial. The length of a dialer must be appropriate to the person's needs,

and dowel rods of different lengths may be attached to the short "ball" dialer until the correct length is found. When the diameter of the rod is smaller than the tube of the spring clip, the rod may be wrapped with masking tape to achieve the necessary diameter. If the patient proves able to use this dialer, a permanent one may be made for him from a dowel rod of the appropriate size.

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Overhead Suspension Sling Support

Overhead suspension sling support provides assistance similar to that of balanced forearm orthosis, and the same considerations apply for using a telephone. In some cases, however, muscle strength at the elbow and in the hand may be adequate to use a handset and dial. This will be revealed by the evaluation procedure.

Elbow Flexion Orthosis

When weakness at the elbow prevents the ambulatory disabled person from voluntarily flexing his elbow, this jointed appliance may be used. The power for flexion is transmitted by a cable from movement of the opposite arm or the leg, or from an external source such as a battery or CO₂ power supply. Extension of the elbow occurs from the force of gravity acting on the weight of the forearm. The elbow may be locked in this position when the orthosis incorporates a locking mechanism.

Telephoning.

The person wearing an elbow flexion orthosis will not have sufficient strength at the elbow to lift the weight of a handset up to his ear. He will flex his elbow first and then grasp the handset—a movement that may require him to lean forward—and afterward prop his elbow on the desk or table to keep the handset by the ear. "Hands-free" equipment would be more suitable for the person who uses the telephone a great deal or who has occasion to take notes.

Pressing buttons may be difficult unless the disabled person has the ability to extend his elbow, or has an elbow lock on the appliance to provide the necessary rigidity. Lever switches may be preferred. His ability to dial may be impaired.

Wrist and Hand Orthoses

The following representative orthoses have features that have significance during the use of the telephone.

Basic Opponens Orthosis

When the C-bar projects along the flexor surface of the thumb, it may interfere with use of a handset. The metal or plastic material may not provide sufficient friction against the plastic of the handset handle to allow a secure grip. When the orthosis cannot be modified, the use of some type of friction tape on one side of the handset handle may be helpful.

ADL Long Opponens Orthosis

A dialing tool may be placed in the pocket on the metacarpal bar to protrude from the ulnar side of the hand or, occasionally, from the thumb side (see p. 97). But when a dialer across the palm does not allow the patient to make contact with the dial hole, it may be necessary to use his spring clip so that the dialer (or a typing stick) points down and along the line of his fingers (see p. 97). When the patient cannot insert and remove a dialer without assistance, the sequence of operations he employs in using the telephone (see p. 61) should be analyzed to insure as much independence as possible.

The patient who has adequate motion in his shoulder and elbow may be able to use a handset despite a complete loss of wrist and hand function. This will depend upon the position of his fingers and whether there is any tightness in flexion. Flail fingers may necessitate a "hands-free" telephone, but when the patient's fingers are slightly contracted, the possibility of his using a Wear-it-or-Hold-it handset should be considered (see Fig. 7, p. 71).

Tenodesis or Wrist Driven Prehension Orthosis

These types of orthoses are used to transform movement at the wrist into a three-point grasp between the first two fingers and thumb. When there is also a complete loss of function at the wrist and hand, the wrist joint is stabilized and an external source of power may be connected to the linkage to open and close the fingers (see Fig. 33d, p. 117).

Telephoning.

The manner in which the fingers and thumb meet together to grasp an object has bearing on the use of the telephone. The thumb is stationary; as the wrist is extended, the first two fingers close down as a unit against the thumb. As the wrist flexes, these fingers are moved away from the thumb and the grasp is opened.

The two fingers together are too wide to be used for pressing one button of a group, as on the Touch-Tone dial, and the thumb may be used instead. As this protrudes only when the wrist has been flexed (when the wrist is extended, the thumb is against the fingers), the Touch-Tone dial may be used when it is turned sideways to

avoid obstruction to the fingers from the cradle posts (see Fig. 13c, d, p. 91).

A dialer held with this type of grasp can point only in one direction—that which has resulted from its most secure anchorage following extension of the wrist. No further movement can take place at the wrist without the dialer being released. Therefore, any alteration in the angle between dial and dialer to permit the most efficient utilization of force must come from repositioning the dial (see "Positioning the Rotary Dial," p. 103).

A dialer tends to be dislodged from the hand during rotary dialing, and it is preferable that a projection from the orthosis be used in the hole of the dial finger-wheel (see Fig. 17d, p. 95). When this is not possible, padding the dialer may allow a more secure grasp.

SELF-HELP DEVICES

Only a few devices are involved in use of the telephone. The most notable of these are the dialing tools and universal cuff, described fully on pp. 44-47.

Writing Cuff

When a writing cuff is used to take notes during telephone conversations, the sequence of operations the patient follows should be checked (p. 61).

Mouthstick

The long mouthstick used by the person with function only at the neck may be used for depressing buttons (including the use of a Touch-Tone dial), and for moving levers. A mouthstick should not be used on a rotary dial unless it is shorter than 8 to 10 inches in length, as the force exerted on the teeth would be excessive. (Therefore, operating a rotary dial by mouthstick can usually only be accomplished by the person with good trunk motion—who is able to hold a pencil in his mouth and lean forward to dial.)

The transmitter end of a handset on a gooseneck arm may obstruct the patient's use of a mouthstick. If a separately mounted transmitter cannot be provided (see Fig. 39), a lightweight headset or Speakerphone may be necessary.

Switches should be as effortless as possible in operation; in some cases a lever may be preferred to pushbuttons.

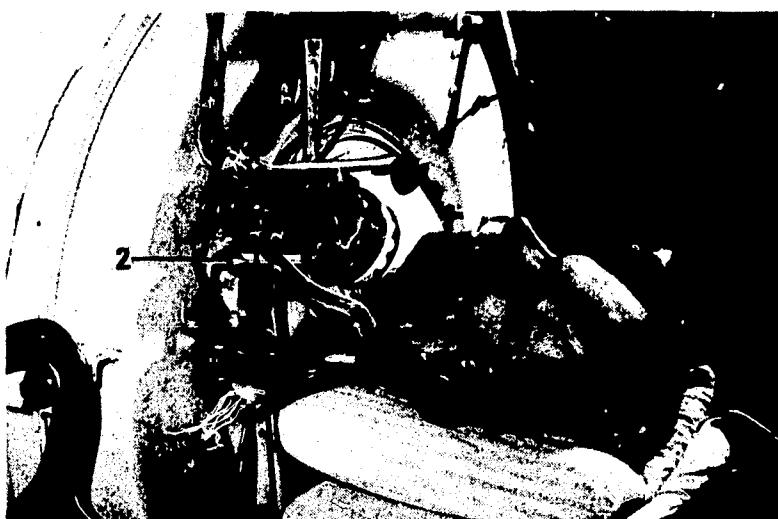
EQUIPMENT FOR RESPIRATION

Rocking Bed

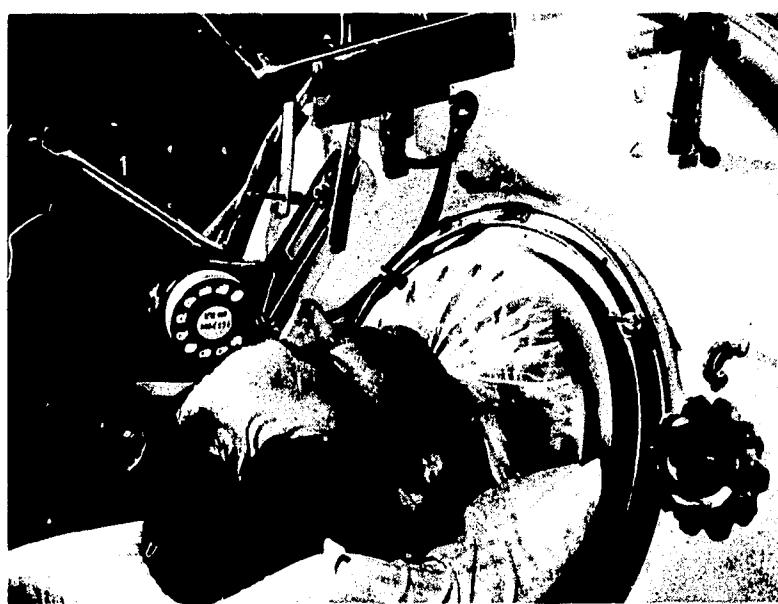
A rocking bed requires special consideration only when the disabled person wishes to be able to use the telephone while rocking. When he can use a desk telephone, it may be placed safely at the center of the bed next to his hips. When "hands-free" equipment is necessary, a Speakerphone or headset with long cord may be used (by special ar-



39a



39b



39c



39d

FIGURE 39

Modified 4A key equipment for use in a tank respirator.

The person able to turn his head only to one side cannot use a handset positioned by his head because it will obstruct the use of a mouthstick. The Wear-it-or-Hold-it set has been disassembled. The receiver is by Mr. D. P.'s ear and the transmitter has been mounted on a swivel arm so it can be swung out of the way during meals or while Mr. D.P. is moved from the tank respirator. A special amplifier was employed to raise the level of received speech so Mr. D.P. does not have to keep his ear against the receiver.

A mouthstick rests in position for use and Mr. D.P. uses it to operate the lever switch and to dial. The mounting cord is plug-ended and jacks have been provided in several locations so telephone service is available when the tank is rolled from one room to another.

(39a) *A tank respirator. The bed on which Mr. D.P. lies is attached to the faceplate (1). When he is moved out of the respirator, the clamps (2) are released and the bed and faceplate are wheeled away from the tank. The 4A key equipment box (3) is attached to a leg of the respirator faceplate.*

(39b) *The modified lever (1) of 4A key equipment is 4 inches long and flat to allow good contact by the mouthstick (2), seen lodging in its easily reached resting place.*

(39c) *The transmitter arm (1) swivels away when not required.*

(39d) *Using the mouthstick to dial. As this installation was made prior to the development of the 9-type dial, a 6-type dial was used. The sliding mounting for the dial (1) permits adjustment of its position to correspond with the arc through which Mr. D.P. can move the mouthstick.*

angement). When a gooseneck arm is chosen, it may be clamped to the mattress frame. Before considering any equipment that must remain close to the patient, particularly a head-operated microswitch, the distance he slides from position during rocking should be observed to make certain that such equipment can be used.

Tank Respirator

Equipment may be secured either to the faceplate or headrest (provided it would not interfere with access to the user in an emergency), or to a stand or wheeled cart which may be brought to the patient as desired. The use of portable equipment will be helpful if the patient spends time away from the respirator and needs a telephone that could be used from more than one position.

Equipment for Conversation.

A lightweight headset is an excellent choice. A Speakerphone may be placed nearby. A Wear-it-or-Hold-it handset (on gooseneck arm) may be used, provided that the transmitter end does not interfere with the use of a mouthstick. It may be preferable to provide a separately mounted transmitter and to attach it to the faceplate. The one illustrated in Fig. 39 swivels to allow access to the patient.

Switches.

A separate switch will be necessary. The key of 4A key equipment may be placed nearby for mouthstick operation, or a microswitch may be used. The switch may be secured to the pillow or headrest and operated by turning the head, or it may

be secured to the faceplate for mouthstick operation.

When a Speakerphone is used, the transmitter may be placed nearby and a separate switch provided; or an attempt could be made to provide a holder on the faceplate into which the transmitter could be placed for the buttons to be operated by mouthstick. A volume-control wheel and enlarged button tops will be necessary.

Dials.

A separately housed Touch-Tone dial attached to the faceplate can be operated by mouthstick when the disabled person is able to reach over its area. The operation of a rotary dial by mouthstick would depend on the patient's strength. If neither is possible, and the person wishes to be able to telephone independently, manual service will be necessary.

Chest Shell

A telephone is chosen according to the patient's physical function. If the patient's physician approves, the chest shell may provide a platform for the attachment of a chin-operated switch.

Positive Pressure Equipment

Either a Speakerphone or a lightweight headset is excellent as equipment for conversation (see Fig. 34, p. 119). A Wear-it-or-Hold-it set on a gooseneck arm will prove suitable if the transmitter end does not obstruct the use of a mouthstick. A separately mounted transmitter and receiver may be preferable.

10.

Special Facilities or Services for Summoning Assistance

Severely disabled individuals are sometimes obliged to remain unattended for varying periods of time. Friends, relatives, companions or attendants cannot always be on duty around the clock. Thus there is a need for arrangements to enable the unattended disabled person to summon assistance in an emergency.

If the handicapped person is able to make outgoing calls, he can call a friend or neighbor, or the police or fire department, in an emergency. If he is unable to manage numbers, or fears he will not be capable of dialing seven digits, he might use a Card Dialer telephone. It could be left with an appropriate card pushed down into the slot, so that all he would have to do would be to lift the handset for dial tone and depress the "start" bar. The card could contain the number of the police department, an answering service, or simply "0" for "operator."

Obviously, if the handicapped person had manual service, he would only have to operate the switch to connect him with the operator. Another method of placing a call is by a one-number dialer (a special assembly, not a standard equipment item). This device, when activated by a switch, would dial a predetermined number where 24-hour coverage was available, such as a telephone answering service. The answering service operator would be provided with a list of people to be notified and numbers to be called in emergencies of various types. Alternatively, the one-number dialer could be arranged to dial "0" for "operator."

A versatile device for automatically summoning assistance is the Alarm Reporting Telephone (ART). The user triggers it by pushing a button, operating a switch, interrupting a light beam, or closing an electrical circuit in any other way he may choose. The ART is available from the telephone company and the triggering arrangement is furnished by the disabled person. The ART switches on, waits for dial tone, and dials a predetermined number. Then it gives a message that has been recorded earlier. If the called number is busy or does not answer, the ART automatically redials and tries again until the message is acknowledged.

A disabled person living alone may fear that he could not reach the telephone or a switch if he fell or became ill. For this situation, some telephone answering services offer a "reassurance service." An answering service operator telephones the shut-in at agreed-upon intervals (e.g., daily, twice daily, hourly). If no answer is received, the answering service operator has instructions to notify someone to make an investigation.

It is sometimes possible, on a special assembly basis, to arrange a Speakerphone installation so that it switches on automatically when there is an incoming call. Thus the handicapped person has no need even to press a button to answer. When the words "Are you all right?" come out of the loudspeaker, all he has to do is to answer, "Yes." If he fails to reply, the caller can summon assistance.

11.

The Use of the Telephone for a Business at Home

The person so severely disabled that he is limited to working at home has few vocational opportunities open to him. One area of work in which physical condition makes little difference is that involving use of the telephone. Some services offered over the telephone will require the ability to record transactions.

Arranging group meetings can take a great deal of the organizer's time and assistance from another person may be welcomed. For clubs, civic organizations, churches, conventions, political organizations and reunions, the disabled person could schedule and plan meetings, make the necessary reservations, or call to remind members of the time of the meeting. Another area of arranging meetings would be to organize home demonstrations for manufacturers of cosmetics, housewares, etc.

Research can be done by telephone, such as TV & advertiser's surveys, market research, opinion polls.

Some disabled people have considered that having a telephone answering service will allow them to work at home. A service where the disabled person answers one or two other phones—such as in taking doctor's calls—can be established easily by the provision of an "off-premises extension," provided that the telephones are geographically located to allow this. Equipment for an answering service that handles many calls, however, is expensive and may prove impracticable for the dis-

abled person to manage. Further information may be obtained from the Marketing Coordinator.

A simpler way in which a telephone may be used is in operating a message center. Some examples are: taking messages for salesmen who come in and out of town; taking calls for those without full-time help—for plumbers, electricians, contractors, real estate agents, ministers, etc.; taking orders for out-of-town businesses for products advertised in local papers; running a baby-sitting service; running a pet-sitting service; organizing a Nurse's Registry.

Unsolicited selling over the telephone is not well accepted by the average householder and it is recommended that any selling by telephone be done on a business-to-business basis only. Examples of this are selling advertising for calendars and programs on behalf of a local printer, or soliciting advertising from local merchants for the community newspaper.

The disabled person could make inquiries from the small business firms in his area to find out how he could be helpful to them by using his telephone from his home. A list of the types of work that could be performed is given below. Blank spaces have been left for the evaluator's notes on information relevant to his locality.

The Telephone Company has brochures on most of the subjects listed. These contain suggestions for the most effective way to use the telephone,

BUSINESS AT HOME

and a discussion on the personal qualifications that are desirable—such as a pleasant manner—for anyone considering using the telephone as a means of employment. The brochures are available on request to the local telephone office.

Attracting accounts.

Insurance renewals.

Reviving inactive accounts.

Repeat sales.

Collecting overdue accounts.

Screening mail inquiries.

Marginal accounts.

Answering letters.

Qualifying prospects.

Customer service.

Making appointments.

Telephone answering service.

Arranging group meetings.

Research.

Skip tracing.

Coordinating production.

Credit management.

Coordinating distribution.

Wake-up, reminder, and reassurance service.

12.

Coin Telephones for the Wheelchair User In Hospitals and Institutions

Many disabled people would be able to use a standard coin telephone if it were placed at a suitable height and if provision were made for easy access.

A new model of coin telephone is under consideration by the Bell System, but until one suited to the handicapped is available, the installation of existing models can be carried out in such a way as to provide the least impediment to their use.

The suggestions for placement away from the wall, and the possibility of using a separate switch and headset, are feasible only when the telephone is in a location reasonably protected from vandalism.

Types of Coin Telephone

Many types of coin telephone are available, the most common being the type where the coin is inserted flat, such as the series 100 and 200. A recommended model is 1A1 or its equivalent, however, since all its features are easier to use than those of series 100 and 200 (Fig. 40).

Change of Installation

When possible, the 1A1 or equivalent should be installed and mounted as described later. If the existing installation must be retained, its usefulness will be increased if it can be mounted suitably. If this is not possible, the length of the handset cord *must* be checked to see if it will reach far enough for the person in a wheelchair to use it.

The standard length is too short and a longer cord should be installed. The handset should be a G3 type.

Installation as an Open Booth

Width.

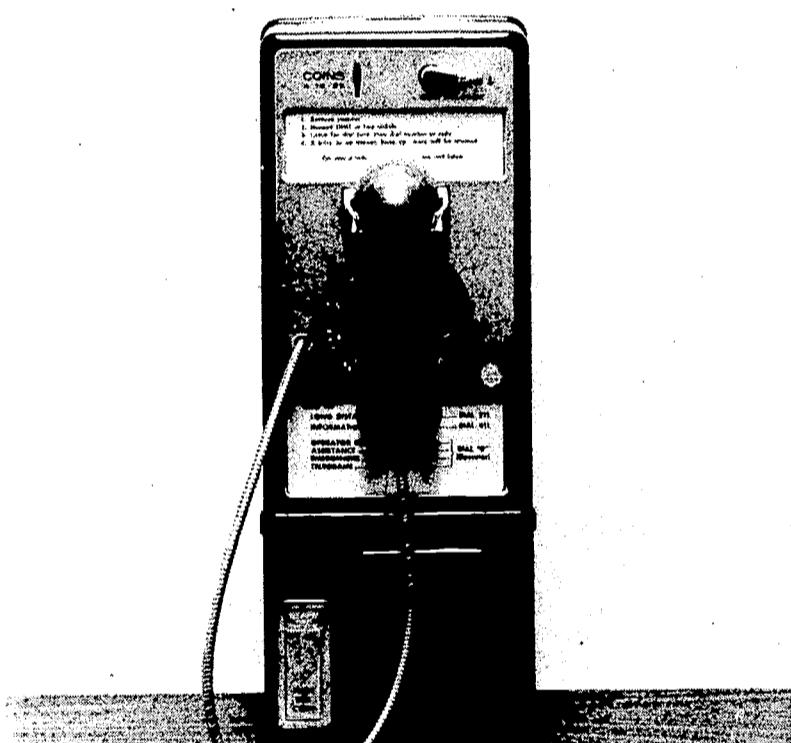
The ideal mounting requires a total width of 56 inches of wall or open booth space. The telephone must be mounted in the center of this space and the booth should be acoustically treated.

The minimum width is 46 inches. This measurement is calculated from observations in the study as being sufficient to allow some wheelchair patients with loss of hand function the opportunity to use the coin slot by approaching it diagonally. When the wrist and fingers are used as a unit for holding the coin, the coin will project at an angle from the forearm axis. In order to place the coin in the slot, the *arm* must be appropriately angled to the face of the telephone, and therefore the user and wheelchair must be to one side (Fig. 41). However, a greater number of persons with loss of hand and arm function will be enabled to use the telephone when a 56-inch width is provided.

The very severely disabled patient will need an assistant to put in the coin and dial for him. The space that an assistant must have in order to stand at the side of the wheelchair should be considered when planning this type of installation.



40a



40b

FIGURE 40

Coin Telephones—200 Series and 1A1.

(40a) *Series 200: The coins are inserted flat. The dial is the 6-type and hard to turn. The coin return requires the use of both hands and good finger function. The handset hanger is at the side and is movable; the handset must be lifted $1\frac{1}{8}$ inches in removing it.*

(40b) *Model 1A1: A coin is inserted by edge and will roll into the slot. The 8-type dial is easily moved. A coin may be retrieved by the use of one finger. The handset is centrally located, making it easy to reach. Because it rests on a rigid hanger, the handset needs to be lifted only $\frac{1}{2}$ inch to remove it.*

Depth.

When a wheelchair is moved toward a telephone mounted directly onto the wall, the projecting footrests will prevent a near approach. Only those persons who can lean forward and who have good use of their arms will be able to use the telephone.

A wheelchair user can reach a coin telephone most easily when it is mounted on a projecting shelf. A false wall beginning at the height of the shelf will allow the telephone to be mounted forward, leaving the room for wheelchair footrests under it. When all patients using the telephone have the footrests of wheelchairs down in the normal position, the depth from the front of the telephone to the rear of the wall underneath should be at least 16 inches. If, however, it will be used by patients with their footrests elevated, this distance should be greater.

Height.

The telephone mounted on a shelf allows the wheelchair user to pull under it. The shelf should be as thin as possible and wide enough to project from the face of the telephone 3 to 4 inches. The projection will enable the user to place money on it and to rest his elbow when reaching for the handset, and a thin shelf allows the telephone to be mounted as low as possible to assist those who have difficulty in reaching the coin slot. The distance from the lower surface of the shelf to the ground should be 30 inches in order to allow access to all standard wheelchairs. A greater height would be needed if patients use raised arm rests or lapboards. However, raising the shelf will require the coin slot to be raised for all wheelchair users, and an evaluation should be made by each institution of the types of patients and their needs to determine the best height for its population. Where several telephones are in use a proportion could be raised, with the others installed at the 30-inch height. When coin telephones are being installed for the use of children, lower heights will be needed.

Installation on a Wall

The above specifications should apply in all cases. Where consideration of space forces the installation of a telephone on a corridor or room wall, it should never be placed in a corner or by an abutment. This position (and the use of a corner-mounted coin-telephone shelf shown in Fig. 42) will penalize the wheelchair patient who has poor use of only one arm. A clear space of 3 feet on either side will allow good access.

Noise is a serious problem that is encountered when a telephone is installed in a corridor, and for this reason an acoustically treated open booth is always preferable.

Impaired Hearing Handset

When several telephones are available for the use



41a



41b

FIGURE 41

Approaching a wall-mounted telephone.

The foot pedals of a wheelchair will keep its user at a distance when approaching a wall from the front. Unless strength in his arms and trunk is sufficient to allow a person to lean forward, he must approach a telephone mounted on a wall from a diagonal or parallel position.

Attempting to use the arm nearest to the telephone results in an awkward and cramped position. For unhampered use of the hand, the outside arm should be used across the body.

The angle taken by the wheelchair to the wall is most important when using a coin telephone. (The model shown is 1A1.)

The person without finger function can hold a coin when he can extend his wrist to produce a tenodesis grip.

The angle at which the coin is held in the hand cannot be altered without dropping the coin. As the coin must align with the slot in order to roll into it—and the only way to accomplish this is by moving the whole arm—an accurate position of the wheelchair in relationship to the coin slot is a critical factor in successful insertion of a coin.

(41a) The wheelchair parallel to the "wall" does not provide the correct angle for the coin. The coin cannot be inserted.

(41b) When the wheelchair is positioned diagonally, the coin is at the correct angle for insertion.

(Spinal Cord Quadriplegic, Group E.)

of the patients, at least one should have an impaired hearing handset.

Installation of Directories

These should be low enough and of the type where the books lie flat and only need opening to be used.

Techniques of Using a Coin Telephone**Wheelchair Approach.**

In general, the patient in a wheelchair unable to approach the telephone head-on operates it best when approaching diagonally, with the arm to be used reaching across his body (Fig. 41). Attempting to use the near hand to manipulate handset, dial, and coin slot results in an awkward position, restricting the full use of the arm.

The position of the wheelchair is frequently dictated by the hand function of the person using the telephone. When his fingers are flexed and contracted, he may need to back his wheelchair diagonally to the wall so that his fingertip may be inserted in the hole of the dial finger-wheel. (With a Touch-Tone dial, he can make a straight approach if he is able to use a knuckle on the buttons.)

Inserting a Coin.

Model 1A1.

In this model, a coin is inserted on its edge and will roll into the slot.

The patient lacking finger and thumb function may hold the coin by a tenodesis grip. When he attempts to place it in the slot, the direction in which it points relative to the slot should be observed. When the patient cannot alter the coin's alignment in his hand, the position of the wheelchair should be changed.

This type of slot allows the upper extremity amputee to use his terminal device for inserting coins.

Series 200.

A coin is inserted flat into one of the three coin slots until it reaches the back, and is then released to drop. The thumb is usually used to push the coin in place.

The patient lacking finger and thumb function may be able to place and hold a coin against the flat front of the coin slot with his thumb. He then slides the coin along until the hole is reached. An upper extremity amputee cannot insert a coin

with his prosthetic terminal device into this type of coin slot.

Coin and Dialing Sticks.

When the patient cannot reach the slot, a curved plastic or metal stick (Fig. 42) with an adhesive substance at the end can be used ("Hold it"—an adhesive rubbery substance available from stationery stores—is recommended). The coin is pushed into the "Hold it" and then placed against the dial slot. Gentle leverage on the stick will release the coin and allow it to drop into the slot.

Two such devices are illustrated on p. 56. They are only practicable when one coin is to be used for a local call or to reach the operator.

The plastic stick is useful when Touch-Tone calling is available or when the user does not have sufficient strength to use a rotary dial. This person will require an assistant to place the call for him but the stick allows the disabled person to deposit additional money for an extended call, or, if the original call has been made through the operator, to place another call. He recalls the operator by depressing the switchhook with the stick, then uses the stick to insert another coin.

The metal stick is useful for the person with sufficient strength in his arms to turn a rotary dial. It is very light in weight ($1\frac{3}{8}$ oz.) and slightly flexible. Flexibility is not desirable but while greater rigidity can be obtained by using a different material this would increase the weight of the device and thus present an even greater difficulty to the user.

Dialing.

Model 1A1 has the 8-type dial, which is significantly easier to use than the 6-type on series 200. Patients who cannot use their fingers to dial may hold a dialer or pencil. Threading the dialer through the fingers allows some grip, and holding the other hand over the closed fingers makes the grip more secure.

Headset and Switch

In institutions housing many severely disabled people, it is most helpful to have coin telephones that can be used by those unable to hold a handset. The coin telephone division of the local Telephone Company can install a headset and switch, by special arrangement, that will allow conversation without the need for someone to hold the handset for the patient.

The headsets available are either the operator's headset or the Wear-it-or-Hold-it set as headset. Both have disadvantages. Since the operator's headset requires several adjustments, an assistant who places it on another's head must learn how to adjust it. In a large institution, this may not be practicable. The Wear-it-or-Hold-it headset has



42

FIGURE 42

Use of a stick for inserting money.

The person unable to reach the coin slot with his hand may employ a lightweight angled stick. A piece of adhesive substance, such as "Hold-it," is placed on the end of the stick and the coin is pushed onto it. This will hold the coin until it is placed in the slot, when gentle leverage on the stick will release it.

(Muscular Dystrophy)

only one simple adjustment, but is comparatively heavy and cannot be used in comfort for more than a brief conversation by anyone who cannot adjust its weight on his ear.

Headsets which cut out noise by covering both ears, which are easy to place on the head, and which have a simple adjustment for positioning

the transmitter, may be provided by the Telephone Company through special arrangements. In the study, a gooseneck arm holding the Wear-it-or-Hold-it handset attached near the telephone has been considered as a possibility for use by those unable to hold a handset, but no test of its feasibility has been made.

Appendix A

THE DIAGNOSTIC AND DISABILITY CATEGORIES OF THE 305 PATIENTS EVALUATED DURING THE STUDY

The Aging—General Problems, 12
Amputation of the Upper Extremity, 18
(congenital anomalies, 2
 shoulder disarticulation, 2
 bilateral shoulder disarticulation, 1
 above-elbow, 3
 bilateral above-below, 2
 above-elbow, below-elbow, 1
 below-elbow, 7)
Amyotrophic Lateral Sclerosis, 3
Cerebral Palsy—Spastic, 8
Cerebral Palsy—Athetoid, 10
Fredrich's Ataxia, 2
Guillain-Barre Syndrome, 2
Hemiplegia, left, 33
Hemiplegia, right, 33
Multiple Sclerosis, 14

Muscular Dystrophy, 15
Parkinson's Disease, 16
Perceptual Deficits, 5
Poliomyelitis, 30
Polymyositis, 1
Polyneuropathy, 3
Pulmonary Emphysema, 2
Quadriplegia—traumatic spinal cord injury, 55
(Group A, 7
 Group B, 9
 Group C, 17
 Group D, 8
 Group E, 11
 Group F, 2
 Group G, 1)
Quadriparesis, 13
(brain stem lesion, 3
 traumatic brain damage, 10)
Rheumatoid Arthritis, 29
Syringomyelia, 1

TOTAL—305

Appendix B

FUNCTIONAL ANALYSIS OF USING THE HANDSET

The type of telephone available to the patient is largely determined by whether or not he can use a handset. A patient who can use a handset has the widest choice of telephones and the freedom to use those of others when he is away from his own installation.

The physically handicapped may have to use compensatory motions; each person will develop his own method according to his residual function. To determine whether it is feasible for him to manually use a handset,* account has to be taken of the residual function in both upper extremities, the ability to move the trunk, the ability to move the head to align it with the handset, plus the suitable choice of equipment.

A determination of the patient's capabilities is based upon two aspects of arm function; the ability to move his arm to place his hand by his head and the ability to maintain hold of the handset. Either may be impeded by changes in joint range of motion, insufficient muscle strength, or loss of coordination, alone, or in combination.

While the ingenuity of the 305 patients observed has demonstrated the inadequacy of measurement as a means of predicting ability, the following observations indicate the minimum residual function necessary to use a handset.

Change In Joint Range of Motion. Loss of range of motion in the joints of the arm, particularly loss of flexion at the elbow and loss of external rotation at the shoulder, may make it impossible for the patient to use a handset. The amount of loss, however, is of less significance than the position taken by the arm; ankylosis at the shoulder, elbow, and wrist are not in themselves a bar to lifting the handset and moving it to the ear when the action may be accomplished by scapular motion and forward bending of the trunk and neck. Joint laxity or loss of range of motion of the fingers do not necessarily prevent the patient from taking the handset off the cradle; the fingers and thumb may not be used at all when the handset can be lifted between both hands. Stiffness of the wrist which produces an unyielding joint may not be a handicap, whereas destruction of the ligamentous attachments resulting in an unstable joint may seriously affect function.

*The simple test used in the gross evaluation of functional motion is described on p. 69.

Loss of Muscle Strength. The study has shown so many variations in methods of compensation that sole reliance cannot be placed on the sum of residual muscle function.

The ability to forward flex and externally rotate at the shoulder and to flex the elbow are necessary to place the handset by the ear.

Holding the standard handset in the absence of functional finger flexors depends upon the patient's possessing the following minimum function at wrist or fingers:

Wrist extensors only: The patient with functional wrist extensors may have a tenodesis grip that enables him to grasp the handset. When tension in the flexor tendons of the fingers is not sufficient to allow such a grasp, the stability to the wrist afforded by the wrist extensors may still permit the patient to use the handset. He can hook his thumb under one end of the handset to raise it off the cradle, and by balancing it in the web of the thumb, bring the handset to the ear.

Wrist flexors (in the absence of power in the fingers) can be utilized in holding the handset when both hands can be used, one at either end of the handset. Another method may be employed when full supination is possible. The palm of this hand is moved under the receiver end until it is under the handle while the other hand stabilizes the handset by pressing on its top. Once the patient has lifted the handset, he will bring it to his chest, and sliding the handset against it, nudge it by stages to his ear. (Any method of reaching simultaneously with both arms can only be used by the person with adequate trunk balance.)

Fingers—long extensors. Either the handset may be pinched between two extended fingers or the fingers may be slipped under a strap around the handset handle (see Fig. 6, p. 68).

It should be noted that while motion at the wrist or fingers, or use of the thumb as a hook, will be necessary in order to hold a standard handset, using the Wear-it-or-Hold-it handset only requires stability at the wrist and tension in the finger flex-

ors (see Fig. 7, p. 71). It does not require motion in the fingers or thumb.

Neuromuscular Incoordination

Ataxia

Ataxia will not prevent the patient from using a handset when both hands can be used to bring the handset to the ear. Using both hands may not be possible, however, when the patient has very poor trunk balance, or the ataxia is severe. Also, the patient who can bring the handset to the ear may not be able to maintain this position.

Athetosis

Severe athetoid movements usually will prevent the patient from using a handset. If he is able to place a shoulder rest in position, he may find it possible to use a handset.

Spasticity

A patient must be able to grasp and release the handset and to flex the elbow. In moving a standard handset to the ear, the spastic arm tends to flex at the wrist, pronate at the forearm, and abduct at the shoulder. From this position, a handset cannot be aligned with the ear and mouth. The patient who is able to forward flex the arm at the shoulder and who has minimal spasticity of the internal rotators, can usually use a handset. Assistance in supinating the forearm is gained by using the following method. Before the handset being raised nears the head the patient turns his head away. He presses the rim of the receiver behind his ear, so that by turning his head forward and horizontally adducting his arm, the handset can be brought into good position by his ear and mouth. The maneuver also eliminates the risk of the patient striking his face with the handset during its use. (The Wear-it-or-Hold-it handset may evoke less spasticity at the wrist than the standard handset, p. 29. The patient who is unable to maintain his hand in a position by the ear may benefit from use of a shoulder rest.)

Appendix C

FUNCTIONAL ANALYSIS OF USING A PARALYZED HAND IN ROTARY DIALING

Dialing exerts pressure around almost all of the circumference of an object used to dial (see Fig. 10, p. 76) and a paralyzed finger would buckle in attempting it unless a way were found to maintain its rigidity. Since pressures against the flexor or lateral surfaces are resisted by the ligaments of the interphalangeal and metacarpophalangeal joints, dialing may sometimes be accomplished despite loss of muscle power when the hand can be positioned to allow the substitution of these joint restraints. Some methods of dialing that are employed by seated patients with seriously paralyzed arms and hands are described below.

Index Finger

Power of Flexion or Extension

Aided by wrist movements, the patient who can flex and extend his finger accomplishes dialing by employing the movement of extension to three-quarters of the way around the dial, and then uses finger flexion to bring the dial finger-wheel to the stop. Good strength at the shoulder is not necessary, nor is the ability to flex at the elbow, other than the strength to move the hand onto the dial and maintain it in position.

Power only of Flexion

The arm has to be capable of placing and main-

taining the finger in the hole of the dial finger-wheel, so that, while the dial is being moved, pressure against the hole can be maintained by the flexor or lateral aspect of the finger. For this, muscle strength at the shoulder must be at a functional level, flexion at the elbow, supination and pronation must be adequate, power to flex or extend the wrist is necessary, and there must be reasonable tightness at the anterior aspect of the wrist. Some of the techniques that can be used are described under *Flail Finger*.

Flail Finger

Dialing can be accomplished with the residual function described above, provided that the tension in the finger flexors or tightness at the metacarpophalangeal joint is sufficient to allow the finger to be used as a post.

The following methods may be used by the spinal cord quadriplegic whose residual muscle function includes pronation of a Poor level.

In use of the right hand, after the finger is placed in the dial hole at "0", and pulled around to approximately 7, the patient has immediately to change into abduction and internal rotation at the shoulder and full pronation of the forearm. This will place the flexor aspect of the finger into a position for continuing around to the stop by movement into external rotation and supination.

The left hand commences in pronation and is moved in internal rotation and abduction at the

shoulder; its switch at 7 is into supination and external rotation at the shoulder; movement of the dial round to the stop follows from internal rotation and pronation (see Fig. 24, p. 101). A variant of this can occur for the initial movement; from a fully supinated position of the forearm, the finger is placed in the hole, the arm moved forward to straighten out the finger and to point it back toward the patient (see Fig. 23, p. 99). Pressure from internal rotation at the shoulder and some pronation of the forearm moves the dial to the 7 position, when the position of full supination and external rotation is resumed. Pronation and internal rotation bring the dial to the stop.

Power only of Extension

Dialing may be accomplished in a manner similar to that described for a flail finger, with some reversals to allow contact with the extensor rather than the flexor surface of the finger tip. If wrist flexors are present in addition to the extensors, then shoulder movements may be less important. (Finger extension that is below a functional level can prevent a finger being used on the vertical dial of a wall telephone, and it may be necessary to use a dialer instead.)

Other Fingers

The middle finger is longer than the index finger and more firmly supported at the metacarpophalangeal joint. Using the middle finger for dialing may be more successful than using the index finger when the metacarpophalangeal joint allows excessive ulnar deviation or, in the right hand, where a short index finger allows the other fingers to catch on the dial. Any finger may be used for dialing in which rigidity can be induced by a controlled muscle spasm or where voluntary movement is present.

Severe Contractures

Severe contractures of the fingers will prevent the

finger tip being inserted in the hole of the dial finger-wheel. Unless a flexed proximal interphalangeal joint can be placed on the dial hole, or the thumb can be used, a dialer may be necessary. When the hand can be turned into full supination, the dorsal aspect of the proximal interphalangeal joint of the little finger can be used. Other methods include using a protuberant pisiform bone in the finger-hole, or pressure may be applied to the dial finger-wheel by the side of the hand (see Fig. 22, p. 99).

The Thumb

The dial is moved by placing the tip of the thumb in the dial hole, but when the tip is too large, the pad of the thumb may be placed flat over the hole.

Flail Thumb

In order for the thumb to be used, it must project sufficiently past the fingers, and to prevent flail fingers from catching on the dial, the wrist may be extended. In left-handed dialing, the fingers will then be in position to provide stability to the thumb by blocking it during pressure against the hand in the most difficult part of dialing, "uphill".

In right-handed use, two methods may be used to move the dial to half-way. Either the pad of the thumb may be placed flat on top of the hole and pressure from the arm will push the thumb tip-first from the "0" to halfway or, the tip of the thumb may be inserted and pressure exerted by the nail. This latter method will be helped to succeed if a tenodesis action (extending the thumb through extensor pollicis longus by flexing and ulnar deviating the wrist) can be produced, or when the thumb can be blocked by the flexed fingers. In both methods, moving the dial from its position halfway around to the stop is then accomplished by pressure from the arm pushing the pad of the thumb against the dial hole. When there is excessive range into extension at the joints of the thumb, the thumb tip may dislodge and dialing fail. A dialing tool will then be necessary.

Appendix D.

TELEPHONE EQUIPMENT FOR PATIENT EVALUATION.

The policy of the local Telephone Company regarding the provision of telephone equipment on consignment may be found by contacting the Marketing Coordinator of Services for the Handicapped. Some items—for example, the handset-holding arms—must be provided by the rehabilitation facility, and some items—for example, the paddle-lever device—should be constructed by them.

The physical facilities that are desirable for the area used for evaluating patients are discussed on p. 8.

Speakerphone

To provide the patient with an opportunity of fully testing a Speakerphone, an operational model is desirable. (See 6-button telephone, to follow.) When this is not possible, however, the patient's physical ability to use the Speakerphone may be tested by using only the transmitter.

The transmitter should have a volume-control wheel. The enlarged tops to the buttons should be removable—to allow the transmitter to be tested with a paddle-lever device.

Desk telephone with headset jack.

This set should have a 9-type rotary dial. $\frac{3}{4}$ in. and $1\frac{1}{2}$ in. levers for the headset button should

	be available. This set may be used to simulate the operation of a two-line telephone, by removing the handset and adding a 2½ in. lever, if desired.
Wear-it-or-Hold-it headset-handset.	
Lightweight headset.	A pair of eyeglass frames, preferably with straight side pieces and without lenses should be available for testing by the patient who does not wear eyeglasses.
Operator's headset.	
6-button telephone (with square buttons)	This set should have a Touch-Tone dial, where available. This set can be used for testing the use of a hold-lever device. (The set will not be necessary if an office 6-button set, with square buttons, can be used and Touch-Tone dialing is not available. Alternatively, if an operational Speakerphone is to be used, its associated telephone could be a 6-button set, with a Touch-Tone dial, where available.)
Separately housed dials.	Rotary dial, 1008B. Touch-tone dial, 1025A3, where available.
6-button Card Dialer with headset jack.	Levers for the headset turnbutton should be available. The card slot may be painted a distinctive color. An extra faceplate with a card guide attached will allow the patient to test its use (the face plate may be inserted as required).
Dialing tools.	"Ball" dialers, one padded with sponge rubber. Short "ball" attachment, with dowel rods of 5-in., 5½-in., 6-in. length and of a diameter that will fit into a spring clip. "Grooved-knob" dialer. Universal cuffs, three sizes.
Sparr Telephone Arm	The 29-in. length is suggested.
Luxo Extension Arm	The 45-in. size is suggested.
Two G3 handsets and two shoulder rests.	It is most convenient to leave the shoulder rests attached to the handsets ready for right- or left-sided use. If additional handsets are not available, the shoulder rests could be attached to the handsets on other telephones when this will not interfere with their normal use.
Key of 4A key equipment, or 6017-type (locking) key.	A 2-in. extension lever should be available.

Appendix E

RATES FOR STANDARD TELEPHONE EQUIPMENT

To obtain the rates for telephone equipment, this sheet can be detached from the Monograph and sent to the Marketing Coordinator of Telephone Services for the Handicapped. After it is returned, it may be secured to a blank page at the end of the monograph. It should be noted that only the rates for standard equipment can be listed; the rates for special assemblies are set on an individual basis.

IMPORTANT: The rates may be changed from time to time and it is important that the list be kept current by checking it occasionally with the Marketing Coordinator. Each change should be dated.

Special Billing Arrangements

Financial sponsorship for a disabled person's equipment may be obtained to cover its initial cost, but is rarely available to cover a recurring monthly charge. A special billing arrangement may be utilized in meeting this need.

"Gift telephone service" allows the monthly charge to be placed on a sponsoring party's telephone bill.

In some instances, the Telephone Company offers a "single payment option." This offers a single payment and no recurring monthly charge.

DATE:	NON-RECUR- RING CHARGE	MONTHLY CHARGE
DESK SET:		
Rotary dial (500)		
Touch-Tone dial (1500)		
TWO-LINE DESK SET (used with one line):		
Rotary dial (510)		
Touch-Tone (1510)		
6-BUTTON DESK SET (used with one line):		
Rotary dial (per additional button required)		
Touch-Tone dial (per additional button required)		
WALL SET:		
Rotary dial		
Touch-Tone dial		
TWO-LINE WALL SET (equipped with one line and the other position used as cut-off):		
Rotary dial		
Touch-Tone dial		
HANGING HAND SET:		

PRINCESS SET: Rotary dial Touch-Tone dial	NON-RECUR- RING CHARGE	MONTHLY CHARGE
TRIMLINE SET: Rotary dial Touch-Tone dial		
SPEAKERPHONE:		
DESK SET WITH HEADSET JACK: Rotary dial (514) Touch-Tone dial (1514)		
6-BUTTON DESK SET WITH HEADSET JACK (used with one line): Rotary dial (per additional button required) Touch-Tone dial (per additional button required)		
4A KEY EQUIPMENT: Rotary dial Touch-Tone dial		
WEAR-IT-OR-HOLD-IT HEADSET (53-type):		
LIGHTWEIGHT HEADSET:		
OPERATOR'S HEADSET (52-type):		
OPERATOR'S HANDSET:		
IMPAIRED HEARING HANDSET:		
WEAK SPEECH HANDSET:		
BONE CONDUCTION RECEIVER:		
HEADSET AMPLIFIER (for switchboards):		
WATCH CASE RECEIVER:		
ELECTRONIC LARYNX:		
TELETYPEWRITER EXCHANGE SERVICE (TWX), 60 speed with page printer:		
TACTILE-VISUAL SET:		
CARD DIALER:		
CARD DIALER WITH HEADSET JACK:		
6-BUTTON CARD DIALER:		
6-BUTTON CARD DIALER WITH HEADSET JACK:		
MAGNETIC TAPE REPERTORY DIALER:		
ONE-NUMBER DIALER:		
AUTOMATIC ANSWERING SET:		
AUTOMATIC ANSWERING AND RECORDING SET:		
WALL JACK:		
MOUNTING CORDS: 9-foot 13-foot		
EXTRA-LENGTH HANDSET CORD:		

Acknowledgements

Grateful acknowledgements are made to the following individuals and departments for their invaluable assistance and advice.

To Gale M. Smith, Engineering Department, American Telephone & Telegraph Company, whose contributions and deep interest made the project possible; to Wally Miller, William McLeod, Charles Spears and A. D. McWhorter, of the Marketing Department, American Telephone & Telegraph Company, and to Dave Garrabrant of the New York Telephone Company.

To Martha E. Schnebly, O.T.R., Muriel E. Zimmerman, O.T.R., Sophia Karafotis, O.T.R., Phyllis L. Palsgrove, O.T.R. and the staff of the Department of Occupational Therapy; to Martha Taylor Sarno, M.A., Director, Speech Pathology Service; to H. Richard Lehneis, C.P.O. and Robert G. Wilson, M.A., Department of Orthotics; to Rosalind R. Zuger, M.A., Director, Placement Services; to Phillip Johnson, Medical Illustration Service; at the Institute of Rehabilitation Medicine, New York University Medical Center.

To Dorothy Pesznik, O.T.R. and the staff of the Department of Occupational Therapy, Goldwater Memorial Hospital.